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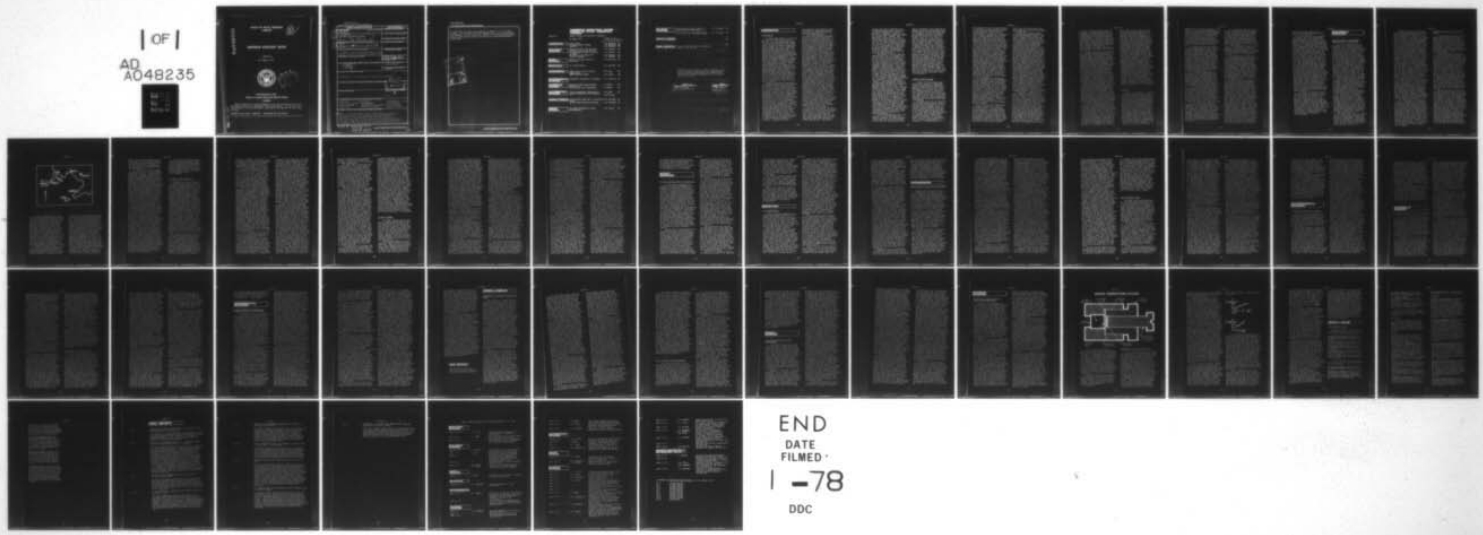

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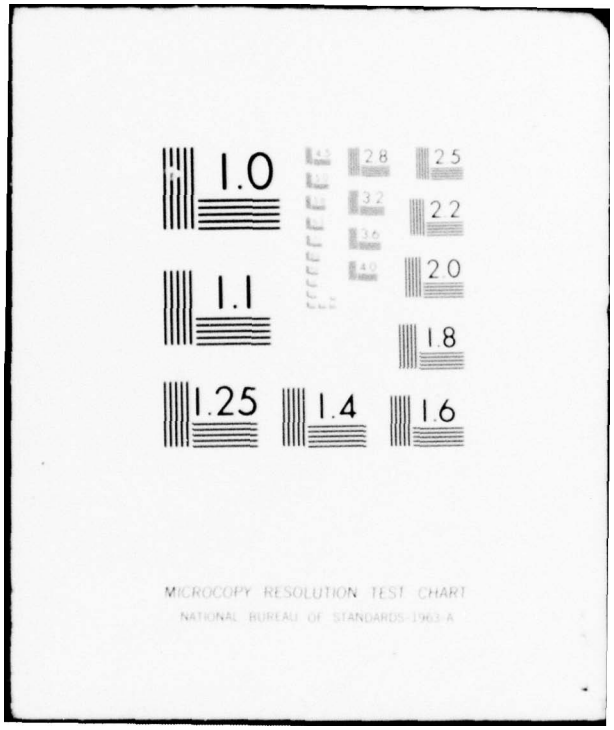
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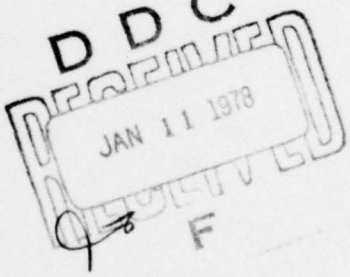

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This is a monthly publication presenting brief articles concerning recent developments in European Scientific Research. It is hoped that these articles (which do not constitute part of the scientific literature) may prove of value to American scientists by disclosing interesting information well in advance of the usual scientific publications.

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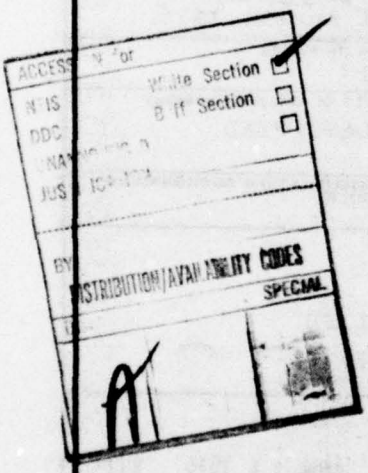

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OFFICE OF NAVAL RESEARCH
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Edited by James W. Miller and Victoria S. Hewitson

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AEROSPACE

SOLAR FLARES

As their name implies, solar flares are transient events that occur on the sun. It is now known that in addition to the increased visible radiation they produce, flares also create large fluxes of energetic charged particles, gamma rays, x-rays (first observed 20 years ago this year by the Naval Research Laboratory (NRL), ultraviolet radiation, and radio waves. These flare radiations cause major disturbances in the inter-planetary medium and the earth's magnetosphere, ionosphere, and upper atmosphere. In turn, these disturbances produce perturbing effects in a number of areas of practical importance, including communications and tracking systems. It is largely because of the importance of these effects that solar-flare monitoring systems have been included in satellite programs such as the Navy's SOLRAD and NOAA's GOES projects. In addition, there have been a number of both ground-based and flight programs, such as the NASA's Orbiting Solar Observatory (OSO) and Apollo Telescope Mount (ATM) projects, that have conducted experiments to study the flare process itself.

While a great deal of important information on flares has been obtained, the nature of their primary energy source is still not fully understood, nor are the reasons for the initiation of a flare. Because of the high temperatures in solar flares (up to 50 MK), the direct attack on these fundamental questions, by using precise spectral measurements to give the temperatures and densities of flare plasmas can only be made in the 1-20 Å x-ray region, where ions at such high temperatures radiate energy. In addition, the small volume and short duration of a flare require that the measurements have high spatial and temporal resolutions. Such an experiment will be carried on the US Solar Maximum Mission (SMM) scheduled for launch in 1979. The three Principal Investigators of the experiment will be Dr. L. Acton (Lockheed), Dr. R. Boyd (Mullard Space Science Laboratory, England), and Dr. A. Gabriel (Appleton Laboratory, England). I recently had the opportunity to visit Gabriel to discuss both this experiment and the other work in process in his Astrophysics Research Division.

Their SMM experiment will be composed of two separate instruments. One will have eight 14-cm^2 bent-crystal spectrometers (BCS) each of which will cover a narrow band centered on a different spectral line in the 1.78 Å to 6.80 Å x-ray region. By using position-sensitive proportional counters as detectors, spectral scanning will not be required and good time resolution, 0.1 sec, will be possible. The spectral resolution will be about 0.0001 Å, and the field of view of 6 arc min^2 will be large enough to cover the active region around the flare as well as the flare itself. The other instrument will be a flat-crystal spectrometer (FCS), which will have seven different crystals to cover wavelengths from 1.38 Å to 19.5 Å. Each will be set on an individual spectral line, but it will also be possible by rotation of the crystals to scan the spectrum across the seven proportional counter detectors simultaneously. This instrument will be capable of either continuously observing a single area on the sun or raster scanning, with 10 arc-sec spatial resolution, the same area on the sun as that viewed by the BCS. The instrument package containing the BCS and FCS will be about 2 m long and weigh about 130 kg. With its many operating modes, this SMM experiment represents a very substantial effort as evidenced by its projected cost of about $6 M. Gabriel's group will be responsible for the total FCS as well as for providing all the crystals for both instruments in this experiment. Even though the FCS electronics, collimator, and proportional-counter detectors will be provided by the other consortium members, the experiment will still require about half the total effort of this somewhat over 30-man group.

In addition, however, the experiment will be the focus for a shift in emphasis of the group from studies mainly related to the quiet sun towards studies of the active sun. Thus, their laboratory spectral-line identification program will be shifting to work with lines produced at higher temperatures. The present

systems they have in operation are a theta-pinch machine and a 4-GW laser, the latter located at the nearby Rutherford Laboratory. Both of these devices can produce plasma temperatures up to about 5 MK. However, the Rutherford Laboratory is building a 100-GW laser which should be in operation by this fall and which this group will use for higher temperature spectral line work. This new laser facility will be comparable in capability to the one now existing at the Naval Research Laboratory in Washington. There are, however, already plans to increase the capability of this new facility (ESN 29-12:530).

The timing of the date when the SMM satellite will fly is especially good for solar flare experiments, i.e., at the time in the solar cycle when the sun is most active. The timing is also very good for this group since the work involved will provide a major program to replace their very active sounding rocket programs. These will largely be phased out in the next 18 months as the UK sounding rocket program is phased down (see ESN 30-8: 347). Prior to the expiration of the rocket program, however, the group will fly a number of additional Skylark rockets. In two of these, echelle spectrographs will be launched from Woomera, Australia, this summer for stellar atmosphere studies. This spectrograph system is similar to that planned for flight in the ESA/UK/US International Ultraviolet Explorer satellite next year. The Appleton group will also have a Skylark flight of their triple x-ray telescope and spectrograph payload. This flight will study the structure of the sun's lower corona by making spectral line measurements in the 150-870 Å region. These measurements are closely related to the study by Dr. R. McWhirter, a member of the group, of the heating mechanism of the solar corona. In this study he is participating as a Guest Investigator in Dr. R. Bonnet's OSO experiment (ESN 30-4:190). Specifically, McWhirter is using the measured profile of the Oxygen VI line at 1032 Å to determine whether the wave energy propagating up from the solar surface into the corona is acoustic or magnetohydrodynamic.

In 1977 the sounding rocket program will include the flight of a Skylark to measure the H/He abundance ratio of the sun. This will be done by measuring the hydrogen and helium Lyman α radiations (1216 Å and 304 Å) coming out from the solar disk as well as the amounts of this radiation that are resonantly scattered by hydrogen and ionized helium from different heights above the solar limb in the corona. Since it is the ratios of the direct and the scattered fluxes that is measured, absolute calibrations are not required. Coupled with the fact that the ratio of ionized to neutral helium can be calculated, an accuracy of about 10% in the determination of the H/He ratio is forecast. Currently the solar H/He ratio is probably uncertain by about a factor of two. The value of this fundamental parameter has important consequences to a number of problems ranging from the composition of Jupiter and the other major planets, to the evolutionary history of the sun, to the nature of the big bang in which our universe was probably created. Whether the Appleton Laboratory's or Gabriel's rocket programs indeed finishes with a big scientific bang remains to be seen, but it is clear that the future course of the group is now both well set and reasonably stable. (L.H. Meredith)

SOUNDING ROCKET PROGRAMS

In May 1976 the European Space Agency (ESA) sponsored a Symposium on Present and Future European Programs on Sounding Rocket and Balloon Research in the Auroral Zone. Since the Symposium in general and the balloon related aspects in particular were reviewed in ESN--this short note will address itself only to the sounding rocket aspects. These represented the major focus for the symposium and occupied about two-thirds of the week-long meeting.

Following some brief introductory talks, reports were given by individual national representatives of the sounding rocket programs in their respective countries. While there are active research groups in most countries who are both willing and able to fly experiments on sounding rockets, it was clear that national support for sounding rocket operations is markedly decreasing. For example: France will fly no more such rockets; the scientific flight program in Germany will be approximately cut in

half between now and the time Spacelab is available in 1981; England's program will be markedly reduced with the strong possibility that by 1978 it will include only launches of the small Petrel rockets; Denmark will continue with a few Nike-boosted rockets per year; and countries such as Austria, Belgium, Norway, Spain and Sweden are primarily thinking in terms of possible cooperative projects with other countries. The reasons for these reductions from a program which has averaged about 40 launches per year over the last decade vary from country to country. The major contributing factors, however, generally include (1) a shift toward supporting more work in space applications, (2) national programs being squeezed out by inflation and the countries' relatively fixed buying power obligations to ESA, (3) the coming of the US space shuttle and the associated European Spacelab, and (4) the fact that ESA stopped support in 1972 because it was felt that the sounding rocket programs were small enough to be done as national programs. While the latter part is generally true, the sounding rocket programs of smaller countries were, in fact, directly impacted and the negative connotation of the action also affected the larger countries' programs.

It was against this background that the meeting continued with presentations describing recent experimental results, sounding-rocket development and performance data, attitude control systems for sounding rockets, proposed new experiments, and the rocket launching ranges in Greenland, Norway, Spain, and Sweden. From the wealth of information in these individual presentations, it was abundantly clear that capabilities have been developed in Europe to implement all phases of sounding-rocket programs. Rather than list everything discussed, I will attempt to briefly describe only some of those highlights that are of rather general interest.

First, Dr. F. Soraas (University of Bergen) presented the results of his recent flight of a collimated x-ray detector on a spinning sounding rocket launched in the auroral zone. From the measured x-ray fluxes he was able to infer the spectra of the auroral electrons striking the upper atmosphere down to energies as low as 3 keV. In addition he was able to map the spatial distribution of the electron precipitation. Such an x-ray system might well find future application in a number of satellite and sounding rocket programs.

Second, Dr. R. Bellat (Centre de Physique Theorique) reported on the French/USSR ARAKS Project. This project consisted of two sounding rocket launches in early 1975 with each carrying a 15 kW electron gun to inject pulsed 15- and 30-keV electron beams into the magnetosphere. By launching from the Kerguelen Islands in the far south of the Indian Ocean it was expected, based both on calculations and the results of similar US experiments, that the electrons would travel along the magnetic field lines of the earth and be observed when they again reached the upper atmosphere over central Russia. While the final results are not now expected for several more months, it appears that radar returns from the beam were indeed observed over Russia but that the returns implied transit-times of the beam from the southern hemisphere a few seconds longer than expected. If verified, this might mean that the electrons in the beam act as a plasma rather than as individual particles. However, since the optical observations of the beam appear to have been minimal and rocket trajectory dispersion seems to have precluded observations of the electrons as they returned to the region of Kerguelen, definitive interpretations will be difficult. The very complete data on four similar US flights reported on by Dr. J. Winkler (U. of Minnesota) strongly indicated that such injected electrons behave as single particles.

In the area of space applications, Germany is planning to initiate a sounding-rocket program for "zero-g" studies. The major impetus for this new program came from a solicitation in Germany for expressions of interest from researchers wanting to fly experiments on Spacelab. Of the over 300 responses, about 60% were in the field of "zero-g" materials and space processing research. To make the best use of Spacelab, they plan to gain early experience in this field by making flights of such experiments on sounding rockets. This program is named TEXUS (Technological EXperiments Under abSence of gravity). As described by Mr. H. Anton (DFVLR), it is planned that there will be one launch in 1977, and then two launches per year until

at least 1981 when Spacelab should be available. The ERNO Company is just completing a definition study for this system which very likely will provide accelerations of less than 10^{-3}g for several minutes, pictures of the experiment while it is in process, rapid cooling of the sample prior to re-entry, and recovery of the payload. The exact specifications depend upon whether the Aries rocket can be used (see ESN 30-6:290). A formal solicitation for the TEXUS experiments will be made this fall.

In the general area of rocket systems, almost no sounding rockets in the past have had active guidance during powered flight. Instead, the rocket launchers have been pointed to give the desired impact point based upon wind-weighted trajectory calculations. At relatively small ranges, however, the impact-point dispersion produced by this method has limited the peak altitudes that can be safely achieved. For example, the limiting peak altitude is about 300 km at the Swedish ESRANGE. To circumvent this problem, Mr. L. Andersson (Swedish Space Corporation) reported on the development by Saab of a guidance system suitable for sounding rockets. Basically, it is a four-fin canard system contained in an approximately 40-kg module which can be adapted for use on essentially any of the larger sounding rockets. The system is composed of a gyro platform whose signals are processed in an autopilot and then used to command a pneumatic system that activates the fins. The fins themselves are disengaged after powered flight to minimize their destabilizing effects. A full test of this system was successfully conducted in January 1976 on a Black Brant VC rocket, and a dispersion of only 8 km for a peak altitude of about 300 km was achieved. The final development flight is planned for 1977 on a two-stage rocket.

Finally, and perhaps of greatest importance, a working group under Dr. B. Hultqvist (Kiruna Geophysical Institute) was formed to attempt to identify cooperative auroral zone sounding rocket projects for the winter of 1978-79. A very good series of steps were taken in this direction. First, it was agreed that four possible projects would be studied in more detail. One would be a high-altitude (greater than 1000 km) and low-altitude (about 300 km) pair of rockets to determine where auroral particles are accelerated. Another would be a long (about 1000 km) flight above quiet auroral forms to study the auroral particle spectra as a function of both the particle flux and the position with respect to aurorae. The third and fourth projects have yet to be defined but one will be to study the D-region and the other will be of an electron gun or plasma release payload. Secondly, it was agreed that the method of cooperation to be investigated will be for individual groups to supply experiments, for the UK to provide the Skylark 12 rocket motors; for Germany, Norway, Sweden and the UK to each be responsible for the integration of one rocket payload; and for most of the rockets to be launched from Andoya, Norway. As the third step, it was agreed that a group consisting of Drs. D. Bryant, B. Hultqvist, and B. Landmark will formulate a detailed plan for these flights including the experiments and experimenters. It is anticipated that there will be a meeting of the experimenters at the ESA ESTEC Laboratory facilities in Noordwijk, Netherlands, in September 1976 to review these plans and to determine whether final payload agreements can be reached. It thus appears as though a means may have been found whereby, in spite of increasingly severe constraints, a very meaningful auroral sounding rocket program in Europe can continue. (L. H. Meredith)

SPACELAB

The US space shuttle is essentially a launch vehicle that can stay in orbit for up to 30 days, normally seven days, and then return to earth for relaunch. It can launch satellites, as can any other launch vehicle, but in addition it can both capture satellites and bring them back to earth as well as provide a platform itself for conducting experiments in space. To make the latter mode of use feasible, a wide range of services including power, data recording, thermal control, mechanical mounting, etc. must generally be provided to the individual experiments being carried. It is to provide such services that the European Space Agency (ESA) has embarked upon a project to build a reusable system that will fit within the space shuttle's cargo bay and fly with the

shuttle into earth orbit and back. This system is called Spacelab and with a budget of about $400 M it is the largest single space project in Europe. Since it is expected that all experiments that stay attached to the shuttle will be serviced by Spacelab regardless of whether they originate inside or outside the US, it is also the European project which could most directly affect the largest number of US space users.

I recently had the opportunity to discuss Spacelab with Dr. J. Burger, the ESA Spacelab Project Scientist, as well as with others at ESA's European Space Technology Center and at the ERNO company in Bremen, Germany. In this short note it is not possible to review fully all the Spacelab capabilities. These are described in an approximately 400-page *Payload Accommodation Handbook*, that was published in May 1976 by ESA. However, some highlights of the Spacelab specifications are appropriate so that those not familiar with the system can better understand the new space capability and what it will provide.

1. Spacelab is designed with modularity so that experiments can be flown in a pressurized module and be man-attended, flown on open structures (pallets), or flown with a combination of modules and pallets. The pressurized module and pallets will both be flown in the space shuttle's 4.5 m diameter and 18 m long cargo bay, whose doors will be opened in orbit.

2. Very large and heavy instruments can be flown in Spacelab, the exact capabilities depend on the type of support the particular experiment requires. A representative value for the volume and mass available in the pressurized module for instruments would be 22 m^3 and 5500 kg. Similarly, if only pallets are flown the instruments can be up to 17 m long, 3.6 m in diameter, with masses up to 10,000 kg.

3. The pressurized module of Spacelab will have a great deal in common with an earth-based laboratory. Within the 4.1 m diameter by up to 6.9 m long module the researchers will work in a shirtsleeve environment, standard equipment racks with both 115/200 V 3-phase ac and 28 V dc power will be provided, and there will be work benches and other general purpose support facilities. Furthermore, the researchers that fly need not be fully qualified astronauts.

4. The Spacelab will be in nearly full-time contact with the ground through the NASA satellite tracking system. Experiment data rates of up to 50 million bits per second will be possible over nearly the full orbit. The only exception will be in a narrow space over the Indian Ocean that is not covered by tracking stations where tape recording of the data will be necessary.

5. An Instrument Pointing System (IPS) is being built as a part of Spacelab. It will be able to point instruments having masses up to 3000 Kg with an accuracy of better than 2 arc sec and a stability of better than 1 arc sec.

From these Spacelab specifications it should be clear that Spacelab will allow experiments to be flown in space that are about ten times larger than those now being flown, with the additional capabilities of being able to have manned attendance of experiments in orbit and to return the experiment to earth after its operation in space. These capabilities will open essentially new areas of space usage in such fields as materials and biological research as well as making possible a wide range of new experiments in the more standard space research areas.

The status of the Spacelab Project is that, after an appreciable study phase, a definitive contract for its construction was signed in September 1975 with the ERNO Company. While ERNO is the prime contractor, the individual subsystems are being built by their subcontractors. The subcontractors were selected so that industries in the ESA countries that are paying for this project receive contracts which almost exactly equal their country's monetary contribution. The contributors are Germany (53%), Italy (18%), France (10%), England (6%), Belgium (4%), Spain (3%), and the Netherlands, Denmark, Switzerland and Austria (2% or under). This contracting method, of course, poses management problems. Coupled with this is the fact that Spacelab has many complex interfaces with the US space shuttle and is being built very nearly in parallel with the shuttle. Thus, there are extensive ESA/ERNO management interactions with NASA. As might be expected at this phase in the project, there are signs of management stresses. Because of this the Director General of ESA, Dr. R. Gibson,

and the NASA Administrator, Dr. J. Fletcher, are now taking personal interests in the project.

On the technical front, however, the project seems to be proceeding reasonably well. At a recent review ERNO provided ESA/NASA almost 10,000 pages of Spacelab systems documentation. While not all aspects of Spacelab were included in the documentation, the technical inadequacies that it was possible to specifically identify were relatively minor and can be corrected. For example, the major one seemed to be that the pressurized module environmental control system was too noisy for the men who would work inside. There are, however, a number of technical areas of concern. Included are the possibilities that total electrical power available for experiments may be 10% or so less than the approximately 5-kw average power expected, that the temperature variations of experiments mounted on the pallets could be larger than desired, and that the time required on the ground to get the Spacelab and experiments all working prior to each shuttle launch might have to be extended. While such potential problem areas can in general all be circumvented for an individual experiment, they could impose restrictions on Spacelab use which might make it more difficult to fly experiments and so compromise one of the major objectives of the Spacelab program: to provide easy access to space. Even so, it appears almost certain that conducting experiments from Spacelab will be easier than from automated satellites.

To assess the technical capabilities and status of Spacelab fully, a detailed technical review of the Project is planned for late this Fall. This review will be critical to Spacelab's maintaining its schedule because it precedes by only about nine months the date the first engineering unit of Spacelab is required. Meanwhile, the process of selecting the experiments that will be on the first Spacelab, scheduled for flight in 1980, has started both in Europe and the US and planning for a second Spacelab flight later in 1980 is proceeding.
(L.H. Meredith)

BIOLOGICAL SCIENCES

NAPLES REVISITED: THE STAZIONE ZOOLOGICA AND ITS NEW DIRECTOR

Soon after learning of the appointment of Dr. Alberto Monroy as Director of the Stazione Zoologica I was able to lunch with him in London. I had met him in 1971 when he was Director of the CNR's Laboratory of Molecular Embryology at Arco Felice near Naples, and had on the same occasion visited the Stazione Zoologica. At that time it was in a sorry state, without a permanent Director. Domestic funding was precarious, and approval of the new Statute (which included provision for appointment of a permanent Scientific Director) had been repeatedly delayed. The authorities were also facing the threatened withdrawal of support for five research "tables" (laboratory spaces) by the US National Science Foundation. Morale was as low as could be, and some of the tales told by people I talked with were depressing in the extreme.

Monroy's appointment is expected to result in many improvements: a permanent Director will at last make it possible for the laboratory to set up formal collaborative agreements at home and abroad, and his own high academic standing should in itself be an important factor in re-establishing the international reputation of the Stazione and ensuring a continued flow of visiting scientists. During Monroy's journey through several countries of West Europe, he was hoping to be able to arrange UK participation involving the Royal Society acting through the Accademia dei Lincei. He was also much encouraged by the interest shown in Germany and Switzerland, and by the expected cooperation of the landlocked European Molecular Biological Laboratory which needs an outlet to the sea, or perhaps one should say, an input from the sea.

The time seemed right for another look at the Stazione Zoologica, and Monroy was kind enough to make the necessary arrangements. My conversations with him and with representatives of three major current research activities are reported in this and three companion ESN articles.

Monroy's policy, briefly, will be to encourage important group projects rather than the anarchic pursuit of personal interests. There is, to be sure, no desire to exclude the visiting scientist with an individual need that cannot readily be satisfied elsewhere, but in a world of nature that multiplies its mysteries more rapidly than the increase of man's ability to solve them, some system of priorities must be erected and a proper balance of investigators and technical facilities must be achieved in order to maintain a reasonable relationship between the increase of knowledge and the effort needed to acquire it. One of the areas to receive encouragement will be developmental biology, especially at the molecular level, with emphasis on the nervous system. In this area, where progress cannot be expected without contributions from several highly specialized domains, it is much regretted that the Swiss scientist Rainer Martin, who had been an important member of the Stazione Zoologica staff for a number of years, accepted a professorship at Ulm. His replacement will be extremely difficult for he provided a point of contact between the neuroanatomists and the neurophysiologists. Another serious loss will be that of J. Z. Young, Professor emeritus of Anatomy at the University College London, who for some years has carried out at Naples an elaborate study of the anatomical and physiological basis of learning in the octopus. Decisions must be made as to the disposition of the large space that he is about to vacate and the facilities, physical and intellectual, that he will leave behind. In view of Monroy's determination to revitalize the laboratory with youthful blood, the decision reached at this point will be crucial.

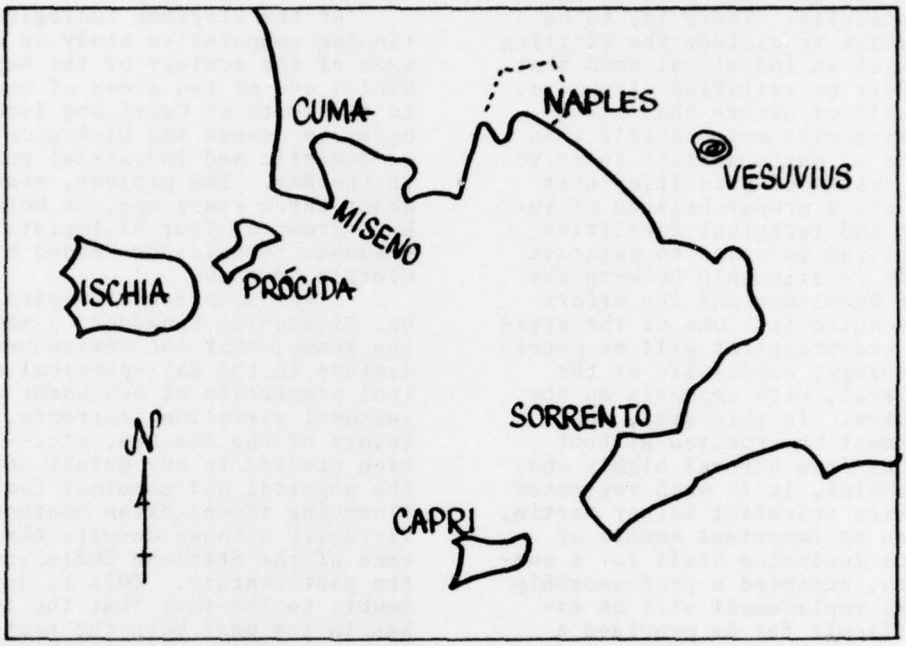
So, good wishes to the Stazione Zoologica! Everyone with a special liking for marine biological laboratories will be happy to know that the one at Naples, which has been a point of attraction for generations of biologists ever since its establishment in 1872 by the German, Dr. Anton Dohrn, is about to take a new lease on life under Monroy. Not least among the reasons for wishing it well at this critical point is the fact that the scientists are descending from their ivory towers to look at the fishing boats and the sewage plants--if only to find out why marine biology isn't what it was, at least in the Bay of Naples. (J. B. Bateman)

THE ECOLOGICAL PLIGHT OF THE BAY OF NAPLES

At the Stazione Zoologica a continuing comparative study is being made of the ecology of the Bay of Naples and of two areas of open sea to the south of Capri and Ischia in order to assess the biological effect of domestic and industrial pollution in the Bay. The project, started about three years ago, is being made by a group of four biologists and five graduate technicians headed by Dr. Giorgio Carrada.

I was surprised to learn from Dr. Gioacchino Bonaduce, a member of the group, that the environmental conditions in the Bay--physical and chemical properties of sea water and their seasonal variation, currents, sedimentology of the sea bed, etc.--have not been studied in any detail and that the physical and chemical factors influencing the plankton benthos are virtually unknown despite the existence of the Stazione Zoologica for the past century. This is due, no doubt, to the fact that the laboratory has in the past been the seat of traditional marine biological research by individual investigators who, even if interested in the characteristics of the marine habitat, would have lacked the facilities for surveying it. So the work begins too late for baseline data to be obtained on the site, and that is why a remote "clean" area has to be used for comparative purposes.

The ecology team is spread thin both in personnel and in facilities, although very well equipped for chemical analytical work. The specialties represented are: primary production of chlorophyll, etc. (G. Carrada); Ostracoda (G. Bonaduce); zooplankton (B. Scotto); qualitative phytoplankton distribution (D. Marino). The hydrography is the responsibility of Thomas Hopkins, a US co-worker in Naples, and crustacea other than the Ostracoda are dealt with in collaboration with the Marine station at Trieste. Efforts are being made to enlist the help of scientists in Austria and Germany, and close personal contact exists with the Marine Biological Laboratory at Plymouth (UK) where the physical and chemical studies of H. W. Harvey and L.H.N. Cooper in the 20's provided the first detailed information about the English Channel.



The Bay of Naples can be seen with a little imagination as a backward C facing roughly to the southwest, with the volcanic peninsula of Miseno at the north and the cretaceous limestone peninsula of Sorrento at the south. Miseno, extended in a southwesterly direction, would bring you first to the small island Prócida, then to the much larger island Ischia. Sorrento similarly extended would meet the island of Capri. A good part of the Bay is a shallow shelf with a depth of about 200 m. Between Ischia and Capri, pointing in toward the Bay, are two canyons 1000 m deep separated by a plateau (100 m); the canyons merge just within the Bay and at their point of confluence produce an upwelling of water long known to the local fishermen for its wealth of marine life.

The city of Naples occupies something like 10 square miles of hills at the northern end of the Bay. Its million inhabitants seem to be stacked almost vertically, swarming over the hills in tall close-packed buildings of much beauty and considerable squalor. For centuries the excrement of the city has been discharged into the Bay, and no doubt there has always been a pollution problem; but while the marine life might cope with 100,000 people, a factor of ten might make all the difference. The existing problems are exacerbated by the fact that while builders are legally required to make provision for the disposal of waste, the means they choose are not closely examined. So there are literally innumerable--that is, uncounted and uncountable--illegal discharges into the sea, and even if the municipal sewage was to be processed, these illegal contributions would escape. An effort has been made to get rid of the municipal sewage by pumping it over a hill, through pipes installed long ago for the purpose, and discharging it at Cuma, to the north of the peninsula. This has resulted in 10 km of lifeless beach, useless to

man or fish, and--the unkindest cut of all--much of the waste is actually carried back by sea currents into the Bay not far from where it began its overland journey. A settling plant, said to be under construction, is not yet ready for use.

As if this were not bad enough, at least three other sources threaten marine life, as well as human safety, in the Bay of Naples. An area which might have continued to grow rich and beautiful from the tourist industry has been invaded by industry of another kind for reasons that need not be set forth here. In paltry imitation of Vesuvius, refineries have been installed next door to the city; these use enormous volumes of cooling and processing water which they discharge into the Bay. Elsewhere the dumping of oil residues and scouring materials from oil tankers proceeds unrestricted. Toward the south, at Castellammare, river estuaries are rendered virtually abiotic by unfiltered waste from the leather industry--except for microorganisms such as *Clostridium botulinum* which flourishes in muds poor in oxygen and produces the toxin of botulism.

I find it very encouraging that the Stazione Zoologica is putting its scientific curiosity about the ecology of the Mediterranean to work in mapping out the facts about the condition of the Bay of Naples. The group is a small one, and it is realized that it must not spread itself too thin. For example, while excellent capability exists for a certain range of chemical analysis, it would be absurdly ambitious to attempt to identify every substance present, and the properties of specimens collected must to a large extent be stated only in terms of their biological effect so as to establish a hierarchy of sensitivities of marine organisms to particular types of ambient insult. Some of the things that ought to be done are not at present being done because they require facilities or advanced technologies that are not available. As an example of the first there is the mapping of the area by aerial infrared photography, which would help to detect thermal pollution and to locate discharge points. Another example is the use of modern technology for mapping ocean currents. The advanced techniques of underwater acoustics would be valuable in refining submarine topographical data and in characterizing the sea bed.

In wishing the ecology group every success in these valuable pursuits, I can only hope that somebody will be available to see that their data, whatever they may imply, are given the weight they will deserve by those whose record of accomplishment as guardians of the environment has been none too good.
(J. B. Bateman)

THE HEART OF THE TUNNY-FISH

The tuna, one of man's ancestors, is scientifically interesting for more worthy reasons than its presence in tins on supermarket shelves. For one thing, curiosity must be aroused by its exceptional cruising speed over great distances and its ability to dive rapidly to depths of 600 m or more. What are the anatomical and physiological foundations of these exceptional powers? Seeking answers, one would first examine the locomotory musculature of the tuna and the heart which keeps the muscles properly perfused. Then there would be comparative studies to find correlations with habit and habitat in closely related species; examination of the homologous organs of animals which preceded and followed the tuna in the course of evolution; work with unrelated genera which may have developed similar, or different, solutions to problems presented by the need for similar performance in a similar habitat. Embryological studies would perhaps provide needed information more quickly, according to the old dictum that "ontogeny recapitulates phylogeny." In my ignorance I would not be surprised if the heart of a tunny fish had already been found in the human embryo, which certainly at one point possesses gill clefts.

Dr. Bruno Tota and his colleagues at the Stazione Zoologica, Naples, are adding biochemical information to existing knowledge of these matters. I gather from talking with Tota that while this knowledge is sufficient to titilate the imagination, the literature is surprisingly scanty and speculation tends to exceed the bounds of established fact. Our conversation provided a necessary reminder of the background of knowledge, to which indeed Tota has contributed, upon which his current

research is founded. In the next few paragraphs I shall assume that the reader is equally in need of refreshment, before going on to mention Tota's recent results and plans as they were conveyed to me verbally and in print.

As anyone knows who has bought fresh tuna at a fishing wharf on Cape Cod, its flesh is red. It contains, in fact, three kinds of myotomal muscle: white, red, and a deep red band near the spine. The red muscle is apparently well adapted biochemically to function under aerobic conditions, such as might be maintained during sustained swimming at moderate speeds. The white, on the other hand, seems to be more suited for bursts of high speed fueled by anaerobic glycolysis.

That is far from the whole story. The tuna, *Thunnus thynnus L.*, though nominally a poikilotherm (cold-blooded), possesses the rudiments of temperature regulatory machinery. This takes the form of an extraordinary counter-current heat exchange arrangement in the red muscle, the *rete mirabile*, by means of which metabolic heat is conserved and the muscle kept warmer than the surrounding sea by as much as 10°C. I do not know how good the internal thermostat is, nor whether the beginnings of nervous control have been found to exist, but it is reasonable enough to suppose that the higher temperature of operation brings with it some advantage to the fish in terms of higher biochemical turnover and greater speed. On the other hand, I have read nothing about the transient temperature of the white muscle during sprinting. Probably nobody knows; the tuna cannot survive in the laboratory because its gills are ventilated solely by the movement of the fish at high speed through the water, and even in these days of telemetry the attachment of thermal sensors to fish at sea would present difficulties.

Since the venous blood from the red muscle is warm when it reaches the heart, is the tuna a warm-hearted or a cold-hearted creature? Both, it seems, and paradoxically so. The ventricular myocardium or pump in some of the tuna's evolutionary forebears was a spongy mesh of contractile fibers in which the lacunae were filled with blood from the lumen of the ventricle, being agitated and renewed by the same contractile movement that pumps the blood into the circulation. In higher warm-blooded vertebrates, in contrast, the ventricular muscle is screened from the blood in the lumen and it is maintained in working condition by a separate blood supply brought in by the coronary arteries. The tuna, in its intermediate position in evolution, has both types of myocardial structure: an inner loose reticulum filled with venous blood entering directly from the ventricular cavity, and an outer compact layer, quite separate from the inner one, which is nourished with oxygenated blood from the coronaries. The spongy layer must be able to function well at the low oxygen tensions prevailing in venous blood; the details of its exchanges with the inner myocardial fibers are apparently unknown, but it has been suggested that they include the processing of metabolites such as lactic acid in a manner rather analogous to that performed by the liver. And here is the paradox: it is the old vestigial inner layer that is kept warm by its abundant supply of venous blood coming straight from the musculature, while the up-to-date outer layer is kept cold by coronary arterial blood from the gills where it has certainly been thermally equilibrated with the ocean.

A number of questions present themselves. One of the advantages of thermal and physicochemical homeostasis is that it limits the variables that have to be dealt with so as to maintain compatibility with functions that must be performed. For instance, the respiratory functions of hemoglobin are carried out very well at 37°C, but what happens if there is a temperature difference of at least 10°C between arterial and venous blood, with corresponding differences in the oxygen dissociation curve, the Bohr effect, and the other factors that influence delivery of oxygen to the tissues and the removal of metabolites? It is advantageous perhaps for part of the engine to work at a higher temperature than the rest, as in the tuna, but what is the price paid in terms of circulatory inefficiency, or what adaptive means have been taken to evade such a payment? Again, what is the mechanism of rapid adaptation to large changes of hydrostatic pressure? How does the tuna, emerging swiftly from great depths, evade or cope with the hazard of aeroembolism?--a question that has been asked also of the whale, a giant reservoir of dissolved nitrogen. What, if any, is the evolutionary significance of the coincidental occurrence, at this stage, of

glycolytic anaerobiosis in locomotor muscles, a compact myocardium with a coronary circulation, and the beginnings of thermal regulation?

No doubt some of these questions and many others will be discussed, if not answered, at a Workshop convened by the Inter-American Tropical Tuna Commission for Autumn 1976 at La Jolla. The scope will be broad, from morphology to fisheries, and interdisciplinary. The group from the Stazione Zoologica will be represented and will present their views on the tuna as a model for the general biology of thermal, mechanical and cardiac phenomena with implications for the human heart and its diseases. In the meantime, some of the results of their laboratory work are available in published form.

This work, by Tota and colleagues, has consisted principally of comparative studies of the three types of skeletal muscle and the two components of the myocardium from the point of view of their probable functions as indicated by biochemical study and electron microscopy. Respiratory enzyme activities have been assayed in isolated mitochondria (complete electron transport preparations) and the types and intensities of the corresponding metabolic activities of the several tissues deduced from the relative values. ATPase activities have been measured in preparations of myofibrils and their values discussed in terms of a supposed correlation with speed of contraction. The results generally suggest that oxidative activity is higher in the red muscle and the inner ventricular myocardium and lower in the white muscle and the outer myocardium, while the ATPase values suggest that the white muscle is faster than the red--as one would expect from their presumed functions as "emergency" and "steady" propellants respectively. However, there is not much difference in this respect between the tuna and the sluggish tub gurnard (*Triglia lucerna L.*); one wonders whether the conclusion concerning relative contraction speeds can really be upheld. There is also an odd and unexplained reversal of oxidative activity in the myocardial mitochondria of the sexually immature tuna: here it is the outer layer which exhibits the greater activity.

The difficulties in pursuing this line of research are considerable, the tuna being an active creature readily studied only when dead. This particular difficulty Tota hopes to circumvent by taking advantage of an interesting example of convergent evolution which has resulted in the development of similar myocardial structures in two quite dissimilar types of animal, the selachians and the teleosts. The first and more primitive, including the sharks, are characterized by their cartilaginous skeleton and by body fluids whose osmolality is brought into equality with that of seawater by the presence of a large concentration of urea in addition to "Ringer-like" concentrations of salts. The second, including the tuna, are the true fishes, with real bone and with blood osmolality maintained by active transport at a level considerably below that of the sea and close to that of the higher vertebrates. One representative of the selachians happens to be the dogfish *Scyllium canicula* which is so frequently seen in laboratory aquaria as to be considered virtually as well domesticated as its mammalian namesake the family dog, and Tota expects to examine the factors leading to condensation of the myocardium by an embryological study of this species. Some work has already been done on the respiration of the spongy and condensed myocardial structures of the shark *Alopus volcanus*. One can only hope that after this tempting detour Tota will return to the tuna and the comparative physiology of the coronaries. (J. B. Bateman)

NATURE'S PHARMACY

From magic potions (eye of newt, etc.) to modern pharmaceuticals and from poisoned arrows to chemical warfare agents the raw materials have been provided by nature. People have noticed their effects and have then modified and improved upon them, usually at the same time finding that poisons can be medicines and *vice versa*: curare and insulin, for example--although it has been asserted over-confidently that the notorious alkaloid strychnine can have no legitimate medical use.

The natural pharmacy is so vast that its resources remain virtually untouched. Many, yet in this context only a few, compounds have been thoroughly investigated chemically and biologically; folklore often leads to others; and beyond that one can only rely upon the naturalist who

records patterns of behavior and suggests now and then that particularly active or interesting chemical mediators must be at work. I say "only," but there is of course the blunderbuss option of testing everything within reach. The feasibility of this depends first upon the availability of people, funds and equipment for the work and second upon criteria of activity--in other words, upon a value system according to which given types of easily detectable pharmacological activity are to be given priority. There is a clear danger that new and potentially valuable types of action will not be manifested in the test systems used for screening, no matter how carefully selected in the light of current concepts. On the other hand, given sufficiently extravagant resources and a reasonable level of professional competence directed to a sufficiently restricted objective, positive results can be confidently expected. In the course of time the excesses will be forgotten and surviving benefits will be taken for granted. Useful antibiotics have been discovered by screening innumerable microbial cultures and new antimalarials identified from among thousands of chemicals synthesized as possible candidates for the role.

Prior to my recent visit to the Stazione Zoologica in Naples I had come upon two interesting examples of the study of biologically active natural products, one in Iran where substances of plant origin are being screened and the other in Italy where insect venoms and pheromones have received prolonged attention.

In the excellently equipped laboratories of the Pharmacology Department of Pahlavi University, Shiraz, Iran, Professor Fakouhi and colleagues were preparing and screening natural products and local remedies, using a mouse model and testing for a wide spectrum of types of action. About 500 plant species had been fractionated and some were sent to the United States for further screening at the National Cancer Institute.

Back in Italy, there is Professor Mario Pavan, head of the Institute of Agrarian Entomology in the University of Pavia, whose outstanding work is an example *par excellence* of the successful biochemical follow-up of behavioral clues which indicate chemical intervention. As a result, a large number of toxins, venoms and pheromones have been isolated and their structures determined. Quite often these compounds prove to have a range of activity unsuspected from the original biological observations that led to their purification. An interesting example to which Pavan has devoted much attention is the substance pederin which causes severe dermatitic and ophthalmic lesions when the coleopterid beetle *Paederus fuscipes* (which secretes it) comes into contact with human skin. The many effects of this substance include blockage of protein synthesis in various cell lines with an activity 10^3 - 10^4 times that of common antimetabolites and, according to the work of others cited in conversation by Pavan, a remarkable capacity to promote cell fusion. A brief review of this and other phases of Pavan's work will be found in *Technical Report ERO-01-75*, 10 March 1975, of the European Research Office, US Army.

My knowledge of the work at the Stazione Zoologica on some of the strange substances produced by marine organisms is derived from a brief talk with Dr. Lucio Cariello, co-author of a number of publications over the past few years, and his present collaborator Dr. Laura Zanetti. Scanning the topics of these papers and the affiliations of the various co-authors, I think it fair to say that the work being done at the Stazione Zoologica is founded upon a catholicity of research interests combined with the certainty that any necessary technical resources are abundantly available to Cariello, for instance within the Stazione Zoologica, or at universities and research institutes such as those in Naples, Rome, Milan and Trieste.

Concerning the research interests, one may say (again not unfairly, I hope) that they are of a comparative biochemical nature, with a leaning toward the identification of substances that mediate observable biological functions in the organisms that produce them, and a preparedness to investigate possible pharmacological or therapeutic implications for man.

Most of the work over the past few years deals with the Coelenterates. One observation, which seems to have been accidental, revealed the presence in methanol extracts of the gorgonian (horn coral) *Eunicella* of homarine, a quaternary ammonium base discovered and synthesized as long ago as 1933 by F. A. Hoppe-Seyler and supposed

to be of importance in nerve function, in osmoregulation, and perhaps of value to the coral in paralyzing its foes and pacifying its prey. Aqueous extracts of the same organism contained a substance crystallized and identified as a tryptophane metabolite, 3-hydroxy-L-kynurenine, which had previously been isolated from certain spiders, insect pupae and butterflies, and shown to be a predecessor of body and eye pigments known as ommochromes.

The sea anemones have long been known to produce toxic substances which accumulate in the cnidoblast, the precursor of the stinging organ; the lethal components have been thought to be polypeptides or proteins of low molecular weight assisted, perhaps, by smaller molecules which facilitate their absorption. Indeed, two polypeptides and one protein have been isolated by different workers; and now Cariello and d'Aniello have isolated no fewer than four protein fractions (molecular weight around 5000), all of which can paralyze and kill crabs, though with differing potencies. The most active fraction is of moderate toxicity as toxic proteins go; 2.5 µg will paralyze a kilogram of shore crabs (*Carcinus maenas*, average weight 20 g) within five minutes and 7.5 µg will kill a kilo of crabs within an unspecified period. Their toxicity for mice and men has not been established.

The most comprehensive study to come from Cariello and collaborators in the University of Naples, in which Zanetti played a prominent part, arose from the isolation of completely new fluorescent pigments from the coelenterates *Parazoanthus axinellae* and *Epizoanthus arenaceus*, colonial anthozoans closely related to sea anemones and stony corals. Combined with preliminary physical and chemical study, the structure of the substance isolated from *P. axinellae* was determined by x-ray examination of a monochlorine-substituted derivative which gave the positions of all the atoms in the molecule, including the hydrogens and three molecules of water of crystallization. This showed that the skeleton is a seven-membered partially saturated carbocyclic ring, fused with two imidazole residues. The seven-membered ring is in a shallow boat conformation, as a result of which the two planar imidazole rings are slightly tilted. In the crystal the molecules are stacked in piles in an antiparallel arrangement, while the water molecules form a hydrogen bond network with each other and with the heterocyclic nitrogen atoms. The substance originally discovered was given the trivial name zoanthoxanthin, and the systematic name 2-amino-3,4-dimethyl-6-dimethylamino 3H-1,3,5,7-tetraza-cyclopent [f]azulene. In the meantime, others with the same skeleton differently substituted, called epizoanthoxanthins A and B, have been isolated, and a new series with the imidazoles attached at different points to the carbocyclic ring has been discovered and called pseudozoanthoxanthins.

These compounds should excite interest beyond that related to their unknown function in the parent anthozoans. They affect mitotic activity in plants in the same manner as colchicine and some synthetic tropoids which possess the same seven-membered ring fused to a single imidazole. According to F. Quadrifoglio (University of Trieste) and coworkers, they combine with DNA, probably by intercalation, although with enthalpies of reaction only around one-half of those found (~-6 kcal/mole) for typical intercalators such as ethidium bromide and proflavine. They selectively inhibit DNA synthesis, with effects on certain DNA polymerases reminiscent of the action of tilorone, a DNA-intercalating broad spectrum antiviral compound. Finally, as Cariello has found in collaboration with B. Tota of the Stazione Zoologica (cf. preceding article in this issue of ESN), zoanthoxanthin inhibits noncompetitively the activity of succinoxidase in particles from beef heart mitochondria containing all the components of the mitochondrial electron transport chain. All in all, there are plenty of questions worth asking and good practical reasons for trying to answer them.

Evidence of other types of chemically mediated response in marine organisms other than the coelenterates are now entering into the research plans of Cariello and Zanetti. A paper describing a toxin from the salivary gland of the octopus, of molecular weight 90,000, is to be published with Ghiretti of Padova. A reported antiviral substance from the cephalopod *Loligo* is to be further investigated. And, entering into the reproductive physiology of the prickly worm *Bonellia*, they will try to isolate the substances responsible for the fact that, in this animal, larval

sex depends upon the duration of contact of the larva with the female worm. Prolonged contact produces males. Cariello did not say whether this is an all-or-none reaction *per se* or whether intermediates are eliminated by social ostracism. (J. B. Bateman)

EARTH SCIENCES

SEA-AIR INTERFACE STUDIES IN MARSEILLES

At the urging of Theodore Von Karman, "L'Institut de Méchanique Statisque de la Turbulence" (IMST) was founded in the early 60's by Professor A. Favre, its present Director. At the time of its formation, Favre insisted that once a sponsor chose a given area of research the Director would then have a free hand at focusing research on specific subjects within that field and that contracts supporting such research were to be provided on long timescales, typically five years. At the time of its foundation the main sponsor was, and to some degree still is, "l'Office National d'Etudes et Recherches Aéronautiques" (ONERA), an entity which is in charge of research in aeronautics in France (ESN 30-7:297). Thus, turbulence occurring in aeronautical flows was the main theme which launched the Institute with experimental (several wind tunnels were located in downtown Marseilles) as well as theoretical work in subsonic and supersonic turbulent flows. I will not dwell on this aspect of the Institute but rather introduce the reader to a recent addition to IMST in the field of sea-air interface studies.

Around 1965, a special commission was created to look into France's expansion or emergence into new research fields, and it was felt that sciences dealing with the physics of the oceans and atmosphere ought to be expanded. The Government turned to Favre for research on small scale turbulence in atmospheric studies, particularly as found in the first few tens of meters above the ocean surface. Laboratory studies were given preference over measurements at sea, for the latter are costly and difficult to carry out, because the motion of the platform on which the measurements are taken always plagues the observations, and one cannot, in general, control and vary the parameters over a range sufficient to gain an understanding of the strong interactions and feedbacks that take place. Laboratory measurements are not without drawbacks: not all the non-dimensional numbers can be scaled realistically in a given experiment, and usually one obtains piecewise results within the parameter range that have to be interpolated to yield a coherent picture of the phenomenon under study.

Dr. M. Coantic was brought into the early design stages of a water-air wind tunnel which can also be described as a micrometeorological wind tunnel, since conditions prevailing on small atmospheric scales can be duplicated. As one of the prerequisites for becoming involved in this project, Favre asked the Government for funds to build one of the best facilities, with the result that the tunnel now is probably unique in its kind. The engineering details can be found in the scientific literature (*Advances of Geophysics*, vol. 18A, 1974, pp 391-405 or *Atmospheric Technology*, No. 7, Fall 75, pp 72-79). The micrometeorological facility is located at Luminy, some 15 km from Marseilles, while the subsonic and supersonic wind tunnels are located in downtown Marseilles. This causes some problems, but presumably in the near future, both installations will be found at Luminy. Suffice it to say that wind-waves as well as mechanically-generated water waves can be induced, the water temperature can be different from that of the air, and stable or unstable temperature stratifications can be set-up in the layer of air.

The research has been focused on conditions found in the open seas, and more emphasis has been placed on the atmospheric layer found above the water surface than on wave dynamics. Work has dealt with statistical characteristics of wind-generated waves, mean and turbulent structures of the wind near the water interface, average rates of evaporation and the effect of a strongly stable atmospheric layer on the velocity, temperature and evaporative heat fluxes. Now there is interest in studying wave-breaking and white-caps and the effect of spray due to this breaking upon the evaporative and momentum fluxes.

Coantic is in charge of this installation which seems to be suffering

from a disease previously encountered at other French laboratories: there is not enough scientific personnel to make full use of this facility. France's Seventh Plan will probably provide for a slight increase in the number of scientific positions. Coantic confided that he spends much too much of his time doing administrative work and seeking contracts to support this installation.

The IMST has several contacts with US universities and several US professors have spent their sabbatical years at the Institute. Also, NATO support has enabled US scientists to perform experiments using the micrometeorological wind tunnel over extended periods of time.

These large, expensive scientific apparatuses are needed and should be made available to the scientific community as a whole. In times of scarce research money, teams with such equipment are among the ones that suffer the most, for they stand to lose the mosaic of skills which are required for the smooth running of such devices.
(A. Barcilon)

EDUCATION

LES GRANDES ÉCOLES

"L'École Nationale Supérieure de Techniques Avancées" (ENSTA) is a relatively new "*grande école*" since it dates back only to 1970, while some of its sisters were founded in the 18th and 19th centuries. Since this concept is not found in the States, I would like to familiarize the reader with such institutions and their role in the French Higher Education System.

What is a grande école? It is an institution of higher learning apart from the University system with the primary purpose of providing a national elite to lead government and industry. Some produce engineers, others administrators and civil servants, while still others prepare one for a career in business. It is difficult to compare them with educational institutions in the States; if we limit ourselves to the grandes écoles for engineers, one could compare their training to Masters' level, or slightly higher, at such institutes of technology as MIT and Cal Tech. These grandes écoles are, for the most part, attached to a given ministry. For example, the prestigious "École Polytechnique" comes under the Ministry of Defense and trains "Ingénieurs de l'Armement," i.e., civil servants working for that Ministry. Their independence from the University system has resulted, over the past decade, in years of serenity for the écoles, while since 1968 the French University system has been undergoing changes that are shaking it to its roots. None of these upheavals have rocked the grandes écoles. There are also other factors responsible for their stability. First, being primarily engineering and business schools, they lack the strong, virulent segments in the humanities which are the most vocal in the universities. Second, most of France's administrative elite are a product of these écoles, which tends to perpetuate the system; a graduate from a grande école has little trouble securing a job even in the present-day tight job-market. In schools like Polytechnique, once admitted the student becomes a civil servant; his salary is paid while he studies and he is assured of a job after graduation. (Note that he must subsequently work for the Government; if he decides to go into private industry, he must repay the Government for the money it has invested in his education.) As well as not having to job-hunt as the university graduate does, a grand école graduate is also assured of a higher beginning salary than the university graduate.

Since the grande écoles are primarily engineering schools, research has not been given the part it deserves in student training. For example, when entering Polytechnique the candidate must state whether he is interested in doing research and continuing for a higher degree. Nevertheless, the curriculum of such schools includes advanced mathematics, physics, and chemistry on levels higher than those found in engineering schools in the US. The importance of research is beginning to be recognized and École Polytechnique is setting up a complex of laboratories in its new location at Palaiseau, just outside Paris. The ENSTA are sharing some of these facilities with other research organizations like the "Laboratoire de Météorologie Dynamique" (See ESN 30-5:223).

Before 1970, the "Polytechnicien" would attend a school of specialization after graduation. It was felt that by regrouping these various schools under a common roof, the ENSTA, one would

broaden the knowledge of l'Ingénieur de l'Armement and of the other engineering candidates and provide cohesion between the various techniques which come into play when a large engineering project is under study. Therefore, the ENSTA is primarily "une École d'Applications." Teaching and to some extent research is carried out according to the philosophy which typifies French applied research. They describe it as "oriented research" which, for them, is not synomynous to applied research but rather denotes "useful fundamental research." As a result their oriented research is far more fundamental than applied research found in the US.

The ENSTA is open to persons who have successfully passed a "concours" (they enter in the first year) and to candidates having a Masters' obtained in the French University system and to Polytechniciens, who enter the second year. The programs span three years. There are six course options: Ocean, Naval, Nuclear, Industrial, Chemical, and Radar engineering. The number admitted to each option is adjusted according to the job-market needs.

My host, Dr. J.S. Darrozes, teaches Fluid Dynamics and Thermodynamics and his teaching spans a variety of the above options. He is one of four full-time faculty members. There are about 1000 lecturers, visitors, and adjunct professors from universities and industry who give from a single lecture to an almost full-load of courses. Thus, students can have an *à la carte* curriculum. The advantages of such a system are that the best qualified lecturers can be called upon to teach a given subject and students have a much broader contact with industry and universities. The drawback is that a sense of unity might be lost when various aspects of a given subject are presented by different individuals. Laboratory sessions are part of the curriculum and all are run by permanent staff members. Students are required to complete an engineering project which, although hypothetical, deals with situations which could be encountered in practice. Darrozes also mentioned that a visiting professor position is made available every year. In the past few years, this position has been filled by US professors on sabbatical.

Although the training provided by these grandes écoles has been tested over the years, some critics point out that the pressures the student undergoes when passing the concours tend to destroy some of the individual originality as far as research is concerned. Also, it is unfortunate that this rigorous training in mathematical and physical sciences rarely leads to a research position. As previously mentioned, graduates from the écoles take-up administrative positions which are looked upon, in France, as the crowning of many years of hard work on school benches. (An ONRL report on the grandes écoles will be forthcoming.) (A.I. Barcilon)

ENGINEERING

LIMSI: FROM A-to-D IN FRENCH ENGINEERING

Like many of the charming towns and villages that ring Paris, Orsay is a quiet haven for the pursuit of academic, scientific, and technological advances under the broad fiscal umbrella provided by the French government. Here may be found the campus of the Université de Paris XI (they are numbered consecutively, through XIII), as well as a variety of institutes and laboratories maintained by the French civil and defense ministries. The *Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur* (LIMSI) is one of over one-hundred laboratories managed by the National Center for Scientific Research (CNRS) which, in turn, is a major agency of the Ministry of Education (see ONRL reports R-10-75 and R-11-75). The close coupling of LIMSI with the nearby academic activities is further indicated by the professional rank of its director, L. Malavard, who is also Chairman of the Administrative Board of ONERA (ESN 30-7:297).

LIMSI is staffed by a relatively small group (less than 50, I would guess) of PhD-level researchers who are divided into four sections according to their interests: Mechanics (Aero and Hydro), Analog Methods, Computer Graphics, and Hybrid Computation. My host at LIMSI was the head of the Mechanics section, Dr. T. S. Luu, who began his review by explaining that the lab was originally a center for research solely devoted to analog methods. These now constitute only a small part of the program, as a result of the massive swing to digital methods that occurred, for LIMSI, around 1966.

A tour of the facilities is sort of an "Upstairs, Downstairs" view of the history of computational methods. In the LIMSI basement (or, as Malavard calls it, "the museum") can be found the fossils of some of the most elaborate analog computers and simulators ever constructed. By means of the electroconductive analogy (termed the "rheoelectrical analogy" by Malavard in his monograph of 18 August, 1956--*The Use of Rheoelectrical Analogies in Aerodynamics*, AGARDograph 18) the laboratory had developed, beginning in 1931, capabilities to model some extremely complicated situations. These included three-dimensional flows and flows with circulation and free surfaces. The inventiveness of the LIMSI engineers was everywhere evident in their efforts to match their laboratory boundary conditions to those of the real world. The equipment appeared to be carefully preserved, and I got the feeling that several of the "old-timers" at LIMSI were still somewhat nostalgic about the crude but tactile methods that had given way to the nanosecond double-precision world of the digital machines. These could be found on the top floor of the building in the forms of several small laboratory-type computers and innumerable terminals and tape machines for access to the main computer center located nearby.

Luu and his coworkers described an assortment of computer-oriented analytical programs that appeared to be very much at the forefront of research in fluid mechanics. He has long been involved in the study of unsteady flows through turbine cascades, and following his earlier work on the analysis of vortex wakes and the forces resulting therefrom, he has more recently turned his attention to the calculation of transonic cascade flows. Together with Dr. G. Coulmy, Luu has recently developed a combined conformal mapping-finite difference method for the prediction of such flows, and comparisons with experiments performed elsewhere show good agreement with Mach-number distribution and shock location in a variety of cascade blade configurations. Results are equally encouraging within the range of angles-of-attack considered: $\pm 5^{\circ}$.

The section has also developed an impressive capability for calculations using the so-called "panel method." This has recently been applied to the prediction of flows past ship hull-forms and propellers and, in particular, to the design of optimal propeller shapes. In an effort to minimize propeller-generated noise, an indirect calculation method is utilized in which a linear decrease in shed vorticity, from root to tip, is specified. The resulting minimization of cavitation (the chief source of noise) has been verified by experiments for the case of uniform upstream flow. The LIMSI programs are now being refined to take into account the non-uniform flows that are due to hub and keel effects upstream of the propeller blade. The problem presents a major increase in complexity because of the unsteadiness that can result from the coupling of the flow past upstream appurtenances with that in the region of the propeller.

The panel method has also been applied to the analysis of an assortment of aircraft and wing configurations, and, as if to complete the spectrum of transport applications, the procedure is now being used to analyze the flow past high-speed trains. In this effort, headed by P. Marty, remarkable success has been obtained in predicting the pressure excursions imposed upon stationary bodies (such as bewildered tourists) located on train platforms during train passage. The velocities of interest are up to 280 km/hr (about 175 mph) and forces of up to 100 N (about 23 lb) can be expected on a cylindrical body located 1.4 m from the train. Moreover, the component of force away from the train is initially about 50 N, but then reverses to a force of similar magnitude in the opposite direction: the bystander is advised to grab something besides his *chapeau*!

France is vigorously pursuing the development of high-speed trains, and such a system is scheduled for operation between Paris and Lyon within the next five years. Prior to this time, however, even more important questions must be answered concerning the forces acting upon passing trains and trains in tunnels. The potential-flow models currently used by LIMSI may not be adequate to this task since it is expected that viscous effects, particularly massive air entrainment, may lead to a "tug-of-war" between the two bodies for the available fluid separating them. In unsymmetrical situations, the unbalanced low pressures may lead to a disastrous affinity of one body for the other.

The researchers in Luu's group are not unfamiliar with viscous flow problems, however, and a typical effort in this regard is that of Coulmy who is

investigating new techniques for the numerical integration of the Navier-Stokes equations. A "viscous panel method" is utilized in which she employs a distributed vortex system with intensity specified at nodes in a triangular finite-difference mesh. For two-dimensional incompressible flow, the vorticity transport equation is discretized for the condition of linearly-varying vorticity between nodes. The method, in effect, draws upon the computational analogies suggested by non-zero values for the divergence of the velocity and that of its curl in compressible inviscid flow and unsteady incompressible flow, respectively. The study is currently in the programming stage, and Coulmy is apparently not yet in possession of results suitable for external distribution.

The Computer Graphics section at LIMSI is headed by Dr. Jean-Marc Brun. The Section is largely involved in the utilization of the computer for the analysis of architectural structures from both mechanical and aesthetic points of view. By utilizing straight line segments, geometric shapes of extreme complexity are first drawn in the usual plane views familiar to the draftsman. With the pertinent intersections and distances digested by the computer, programmed routines are used to view the entire objects from any desired perspective. Design changes are easily incorporated and their visual effects are more-or-less instantly apparent. The system has been used for industrial site layout and for town planning, as well as for the design of small mechanical gadgets of pathological contour. A most fascinating aspect of the work is the use of photomontage methods to estimate the environmental effect of the placement of structures in proposed sites. To illustrate the method, Brun and his group have "computerized" the Notre Dame Cathedral and have overlayed it on a number of areas--the effect is dramatic. On the practical side, for example, a radar tower was "placed" on its proposed site near a small French town on the banks of the Seine. The environmental clash was obvious and the proposal was scrapped--Brun says he is still not on the best of terms with the profit-minded mayor of the town.

The labs at LIMSI appeared to be well stocked with the latest computing equipment and the know-how to go with it. The hybrid computing section was no exception, and here I was treated to a demonstration (always mind-boggling) of a computer voice-reconstituter. The device is marketed under patent (as are many of LIMSI's inventions) and appeared to be quite compact and easy to operate. It is noteworthy, I think, that machines have not yet overcome the language difficulties that continue to serve as enormous barriers to free communications between people of all nations. To test the machines I asked the operator to enter "Good morning, how are you?" The appropriate buttons were pushed and out came gobbledegook. Not to be undone, the operator returned to the teletype and entered something like "Ghoud mooning, haou ââ yoû?" The computer replied in impeccable American, and even though I detected a note of insincerity in the electronic inquiry, I was tempted to reply, "Tres bien, merci. Et vous?" (R. H. Nunn)

SHAPE TECHNICAL CENTER

The SHAPE (Supreme Headquarters Allied Powers Europe) Technical Center is a unit under NATO whose mission is to provide scientific and technical advice to SHAPE as well as to NATO nations requesting such assistance. The Center (STC) also undertakes research and development projects and operational tests concerned with offensive and defensive matters pertaining to Allied Command Europe (ACE). Since 1969 it has occupied a spacious building in The Hague, The Netherlands, next to the Physics Laboratory of the Netherlands Research Organization.

The current Director of STC is Dr. J.S. Burgess, who is due to return to the US soon and will be replaced by another US scientist. The technical functions of STC are grouped into four divisions; namely, communications; mathematics and computer; operations research; and command, control and systems. Each division is further divided into three to five branches. There are about 360 people at STC. Roughly one-third of the total are scientific and technical personnel. The annual budget is around 25 million Dutch guilders, which is about 10 million US dollars.

I visited STC recently when I was attending a technical meeting sponsored by the Avionics Panel of AGARD (Advisory Group for Aerospace Research and Development). The visit was arranged by

Burgess whom I first knew when he was Chief Scientist at the Air Force Rome Air Development Center (RADC). Because of the limited time available, my visit was confined to the Communications Division and the Radar Branch of the Command, Control and Systems Division.

The Chief of the Communications Division is Dr. A.N. Ince. Born in Turkey, Ince received the BSc degree from the University of Birmingham (UK) and the PhD degree from the University of Cambridge (UK). He is a friendly and dynamic person. He has been with STC since 1961 and is very proud of the accomplishments of his Division.

One of the earlier contributions of STC was an adaptive meteor-burst system which made use of automatic request for repetition (ARQ) and diversity reception to provide a reliable and efficient radio channel. STC also designed a compact and transportable ionoscatter system providing four telegraph channels by employing ARQ techniques and diversity. In 1967 Ince and H.P. Williams studied the application of digital techniques and statistical concepts to LF communication. The study included consideration of ground and sky waves, fading, and noise distribution.

In the satellite communications area, STC participated in planning the NATO SATCOM Phase II system consisting of two X-band geo-synchronous satellites and 12 ground terminals which use 40-ft antennas and uncooled parametric amplifiers. The current Phase II system is to be replaced by larger and more advanced Phase III satellites having multiple channels and two antennas--a narrow-beam antenna illuminating the NATO European area and a wide-beam one covering a large part of the NATO area including the Atlantic Ocean. The first of the two new satellites, designated III-A was successfully put in orbit by NASA on 22 April 1976. The Phase III SATCOM System is to be an integral part of the network known as the NATO Integrated Communications System (NICS). The NICS plan is based on an automatically switched, common-user grid network utilizing existing transmission media which include tropo-scatter links and satellite communications. STC's involvement encompassed design and construction of laboratory models of satellites, computer simulation of the complete system, orbit determination and prediction, frequency planning, propagation measurements, and studies of electromagnetic counter- and counter-counter-measures.

For intranet frequency planning it is necessary to measure accurately the system performance as well as the amount of signal suppression and inter-modulation noise produced in a transponder which is accessed by numerous carriers. Both laboratory-simulation and computer-simulation methods are used at STC. Ince showed me STC's laboratory SATCOM simulator. It is an impressive looking set-up. The simulator consists of four basic parts. The first part has 12 independent panels simulating the transmit chains of the ground terminals; the second part is the satellite simulator; the third part consists of the FM demodulator and voice-frequency multiplex equipment; and the fourth part contains the various measuring equipment and instruments. The computer-simulator program produced at STC takes account of the position of the satellite, the geographical location of the terminals, the transmitting powers, the antenna gains, the random losses and the variable weather conditions. The comparative merits of three SATCOM system control concepts (constant transmitting power; constant satellite power-sharing; and adaptive satellite power-sharing have been studied in depth at STC. They have shown that the adaptive satellite power-sharing control concept offers substantial advantages in combating environmental degradations, especially for a network of point-to-point links.

At the Radar Branch of the Command, Control and Systems Division, I talked with A.J. Kampstra, Head of the Branch, and with Dr. J. Pahls and A.J. Poelman. One of the recent accomplishments of this Branch was the formulation of a non-supervised learning algorithm which has the ability to maintain a given constant false-alarm rate when incorporated in an automatic radar-data extraction system in an unknown and changing clutter environment. Several digital area-MTI (moving-target indicator) prototypes implemented with the basic algorithm have been designed, built and tested at STC.

Pahls works on the general problems of target classification and identification. He thinks very highly of a PhD dissertation entitled *Phenomenological Theory of Radar Targets* by Jean Richard Huynen at the Delft University of Technology (1970). Poelman studies the use of adaptive antenna polarizations for the improvement of the target-detection

capability of a radar system in both natural and man-made interference environments. His analytical results indicate that an optimum adaptive polarization system could result in a 4 dB improvement in clutter suppression for chaff and a 20 dB improvement in ground-clutter suppression. Experimental verification of these predicted results is being planned.

STC has a total of 16 well-equipped laboratories. Its main computer facility is a CDC-6400 computer with 16 remote-access terminals throughout its building. In addition to the good physical facilities, STC has generous pay (tax-free), allowance, leave and insurance policies. It can and does attract competent personnel. Since its mission is transnational, it would appear that one of its important functions could be to make impartial recommendations for hardware standardization. At the present, standardization is not a function of STC, mainly for non-technical reasons. This, I believe, is regrettable. (D.K. Cheng)

ENVIRONMENTAL SCIENCES

ATMOSPHERIC CONVECTION IN CLERMONT

The "Laboratoire de Dynamique et Microphysique de l'Atmosphère" is the one center in France that teaches and is actively engaged in field studies which fall into the class of physical and synoptic meteorology. It is located at the University of Clermont-Ferrand, in a town in a mountainous region in Central France.

Prof. R.G. Soulage is the Director of this Laboratory which includes about 35 people, ten of whom are supported by and are affiliated with the University, while about three or four are paid by the Centre National de la Recherche Scientifique (CNRS), the French NSF. Unlike NSF funding in the US, the latter are treated as civil service positions. The Laboratory, founded in 1966, is a witness to France's realization of the importance of research in fields connected with the geophysical sciences and the need for expansion of this research. Although the Laboratory evolved around a Chair which dealt with internal and external geophysics, both of which are found in course curricula offered by the University, research has specialized in the physics of the atmosphere. Their research efforts can be divided into two main streams: cloud microphysics, an area pioneered by Soulage, and more recently, convection in the atmosphere on various scales. This latter research can be subdivided another way by considering the atmospheric layer in which it falls. Under this subdivision one finds: 1) Studies of atmospheric flows in the first few tens of meters above the surface of the ground or a body of water. In this connection the Electricité de France (EDF) which is interested in the cooling and evaporation rates which occur in artifical ponds, supports research in a small crater lake in which three buoys and several meteorological instruments have been placed. Unfortunately, for high wind speeds, the sharp edges of the crater produce a disruption in the lower atmospheric boundary layer. 2) The second atmospheric region, extending from the ground up to about 1 km, is quite important to human activity. Field studies are being carried out on a plain of a small horizontal extent, north of Clermont-Ferrand. Doppler radar will be used, as well as conventional sounding measurements and measurements obtained by instrumented aircraft. Two of France's most sophisticated Doppler radar units are to become operational this year. 3) Studies of convection in the so-called "free atmosphere," i.e., in the region above 1 km, are also underway. These deal with the dynamics and the microphysics found in tall clouds. Such studies are extremely complex: To understand, measure and model a single cloud comes close in complexity to the problem of modeling the general circulation of the atmosphere. These studies on cloud dynamics should eventually provide better parametrization of clouds and their microphysics in some of the large-scale general circulation models and in operational models used in weather forecasting.

The bulk of the Laboratory's support comes from contracts since the University contributes only about 3% of the research expenditure (although it pays for some of the salaries) and the CNRS supports only 15-20%. The various agencies that contract with this Laboratory are the EDF, the "Centre National d'Etudes Spatiales" (study of the formation of frost on meteorological balloons flying at high altitudes); the "Délégation Générale à la Recherche Scientifique et Technique" (DGRST);

and agricultural concerns. Soulage complained that, at this time, they have to turn down contracts for they are understaffed; e.g., a field experiment of a few days duration generates data that takes years to process and understand. Soulage wants to stay away from weather-modification experiments, although he is quite willing to help and discuss the various research aspects with other scientists who might be more involved in the practical side of weather modification. A joint program is currently underway with the Federal Swiss Institute of Technology of Zurich, Switzerland to study hail.

This group has the tools and the know-how to produce interesting research in the areas described above. In the past ten years the tendency has been to shy away from the English-language technical journals and to publish in the French. This tendency seems to be fading away, and one should expect to see more of their research in print in the English meteorological literature. (A.I. Barcilon)

MATERIALS SCIENCE

APPLIED(!) SMALL-ANGLE NEUTRON DIFFRACTION

The scattering of x-rays and neutrons at small angles from the main beam has for a number of years been a useful and sometimes exciting practice in the basic physical and life sciences. The technique had a great impact on precipitation studies in quenched and aged light alloys, in polymer research and in the determination of specific surfaces in certain materials. Much work, of course, has been carried out on biological molecules, where high molecular weights and large spacings are ideal for study at small-angles.

X-rays, of course, have been the main radiation for these studies--that is until recently, when the Institut Von Laue-Langevin was founded at Grenoble, France, and the Kernforschungsanlage (KFA) went into operation at Jülich, West Germany. With the establishment of these institutes, small-angle neutron scattering (SANS) entered the scene. The work at these two laboratories was discussed in two previous reports (ESN 30-1:36 and ESN 30-2:73). More recently another laboratory has become active, the Neutron Scattering Laboratory at the Atomic Weapons Research Establishment in Aldermaston, England. The individuals in charge of the neutron diffraction facility are Dr. E.M. Gunnersen and Dr. R.J.R. Miller. Of particular interest here is the fact that they have begun a program on applied SANS. This, of course, is not really new, the workers at Fiat and Ispra, for example, having begun a program as well. What is interesting however, is the desire to do the applied work in a big way, and, in fact, virtually, to dedicate the reactor instrumentation to this purpose. I should like to report briefly on a recent visit to Aldermaston, and perhaps, to convey the sense of excitement which is apparent at this Laboratory.

The 5-MW HERALD reactor is being used as the neutron source. The reactor is of the light-water pool type, using enriched uranium fuel and a beryllium reflector. Within the thermal column the flux is 10^9 $n/mm^2/sec$. The reactor is equipped with a cold source (20 K) near to the reactor core. This, of course, is important for SANS due to the need to achieve a high intensity of long-wavelength neutrons so as to avoid double-Bragg scattering.

There are a number of beam tubes for diffraction experiments with attendant monochromators and spectrometers. However, I will discuss only SANS and the recent applied tack being taken by Aldermaston.

First, a brief word on SANS relative to its use in studying imperfections in crystals. Non-destructive evaluation is generally used to detect and to characterize imperfections over a wide range of size and type. The modification of the perfect lattice due to the presence of imperfections has also been detected by SANS. The imperfections in question can be voids, cracks, interfaces between phases, or a new phase. The result is that the highly resolved and penetrating neutron beam becomes broadened as it passes through such an imperfect specimen. The details of the broadening are a function of the shape and size of the imperfection in question. The differential scattering cross section (in neutron scattering language) is proportional to the square of the Fourier transform of the shape of the imperfection. The ideal approach would be to extract the real shape of the imperfection by performing the inverse transformation. This difficult procedure is uncertain, at best, due to the

limited angular range of the available experimental data. What is done in practice is to compare the data obtained with a model from a given shape (e.g., Guinier or Porod approximations) and then, by a process of bootstrapping, approximate the shape.

Without going into further detail, it can be said that SANS is playing an increasingly important role in problems requiring the evaluation of very large scattering particles (for example, greater than say 1000 Å) in crystals which have undergone plastic deformation and in which double-Bragg scattering starts to become a nuisance, and for precipitate particles which can't be detected by x-rays (due to the similarity of the atomic scattering factors of the constituent atom species). Furthermore, neutrons are generally more penetrating than x-rays, so there is less of a problem with large specimen thickness. This last item is especially important for applied studies.

Relative to equipment for applied SANS, one requires a cold source, an evacuated neutron beam tube (which is, incidentally, curved to act as a low pass filter--the larger wavelength neutrons get deflected, and carried down to the specimen), good collimation, and a large, two-dimensional position-sensitive detector.

In the HERALD reactor, liquid hydrogen is used together with a rotating-cylinder mechanical monochromator. The current detector is a multiwire BF_3 proportional counter with a matrix of 128 x 128 wires having an area of 0.5 m^2.

The Aldermaston group has begun to look at voids in superalloy turbine blades. Similar work has actually been done before in Italy, but the group here believes that more exploratory work is needed on blades. They are examining voids due to creep of the blades and, like the Italian workers, wish to relate the position of maximum scattering to the position of eventual failure. Miller and Dr. R. Stewart (Reading University) are currently performing a key experiment at the ILL High Flux SANS facility at Grenoble. They are loading a superalloy--at temperature--and looking at the SANS spectra *in situ*! With this approach they hope to detect the very earliest stages of void formation associated with creep. If this technique is shown to be feasible, the experiment will be redesigned for the Aldermaston reactor.

Once the possibilities and the limitations of SANS are appreciated, a number of technologically relevant experiments come to mind. Some examples suggested by Miller include: detection of the overaging of high-strength aluminum alloys; study of unwanted precipitation of various phases in the vicinity of welds; studies of fatigue in thick specimens; detection of hydrogen embrittlement; detection of stress-corrosion (when and if related to hydrogen embrittlement); studies of radiation-damaged alloys and ceramics. Miller feels strongly that magnetic steels (or magnetic phases within steels) can be fruitfully examined with SANS. Powder metallurgy products which are prepared by hot isostatic pressing can have microvoids which can result in failure. SANS, due to its high penetrating power, should be able to detect what is essentially microporosity in such bulk specimens.

Details aside (and there are numerous, not easily soluble problems with the application of SANS), this non-destructive evaluation technique is worthy of very serious consideration. A triumvirate of France, Germany and Italy have applied to the EEC for the initial support of a large technological SANS program. Aldermaston is taking the plunge as well. With still limited results thus far, they have the faith and determination to proceed. The future will be interesting indeed. (H. Herman)

SYNCHROTRONS AND STORAGE RINGS...

All most x-ray experimentalists really want is high intensity, high resolution, good detection electronics, room to work, time, and stability in all of these things. Well, there may be an answer--at least for some of the ills that plague those who analyze matter with radiation. From the science and technology of accelerators has developed serious proposals to build dedicated x-ray sources. The idea is straightforward. The synchrotron accelerates electrons to high energies and when they undergo deceleration, they radiate a wide range of wavelengths of electromagnetic radiation--for our interest here--white x-rays. The intensity is tremendous, so that one can "open a window" in the machine and out will pour a finely collimated beam of x-rays, which has little divergence--and still a large amount of intensity some 60 m from the source. But,

to make this work, intermittent injection of electrons is required, which in turn creates instabilities in intensity. To do the job properly requires the construction of a "large x-ray tube"--a storage ring--into which the electrons are initially pulsed. These electrons give rise to a very stable source of high-intensity white x-rays for as long as five to six hours. Potential users of this sort of machine are thus looking carefully at storage ring experiences and techniques.

There are plans afoot in the US to build a dedicated storage ring. To examine what the experience has been in Europe, I traveled to the Cavendish Laboratory (Cambridge) to visit Dr. A.M. Glazer, an individual who has had numerous and diverse experiences with the British synchrotron at Daresbury. Glazer is, in fact, moving this autumn to the Clarendon Laboratory at Oxford, where he expects to continue research on ferroelectricity (his first love) and to contribute to the development of synchrotron techniques. He feels strongly that storage rings are the way to go and cited numerous problems which have and are being encountered with the multiple-injection synchrotron devices, i.e., poor stability, varying wavelength stability (at a given angle), and distant remote control being required due to the very strong radiation background for multiple-injection machines.

The British actually feel so strongly in favor of the storage ring that the synchrotron facility at Daresbury will close next March for a period of some three years to permit the construction of a storage ring dedicated to the generation and use of x-rays. Glazer is rather disappointed that the Daresbury synchrotron will be closed down for so long. He would have preferred another site for construction of the new storage ring. Meanwhile, the field is evolving rapidly, and Glazer feels that Britain will be left out in the cold while others skim off the cream. This feeling is old stuff to American scientists in a number of fields--so I was able to console him.

Some interesting work of Glazer's, done with J. Bordes and H. Hansen, is on x-ray topography using synchrotron radiation. They were actually after phase transitions in $BaTiO_3$ single crystals, and, using a modified Guinier-Tennevin technique involving polychromatic x-rays, they reduced to minutes the usual complex x-ray topographic method which requires many hours of exposure! In truth, topography of single crystals is a time-consuming job, requiring careful alignment and long exposures due to the very low scattered intensity. Using the synchrotron, on the other hand, one is simply taking a Laue photograph and the intensities are considerable. Thus, they were able to follow easily the tetragonal-to-cubic phase transition in $BaTiO_3$.

Glazer and Bordes, with I.H. Munro, have extended their synchrotron prototype experiments to small-angle scattering, an area which shows great promise for synchrotrons. The synchrotron is a "natural" for small-angle scattering because of its high intensity and low beam-divergence. Also, high linear polarization and a smoothly varying white radiation spectrum offer certain interesting possibilities for data acquisition and analysis. In the present study, and in some recent powder diffraction work, these workers are holding scattering angle constant and looking at the photon energy spectrum. This commonly used technique is especially adaptable to synchrotron work, due to the high intensity and smooth, uncomplicated intensity-wavelength distribution. Thus, energy dispersive analysis is a natural for synchrotrons.

In the experiments undertaken at Daresbury, 5-GeV electrons are used to obtain synchrotron radiation having a spectrum which extends from 0.1 Å through the infrared region. The collimated beam is confined to a cone having a half-angle between 1.0 and 0.1 mrad. The circulating current is 20 mA, yielding 10^9 photons/sec at 1 Å wavelength.

There are several synchrotron units extant: NINA (Daresbury, UK), DESY (Hamburg, W. Germany), SPEAR (Stanford, US) and, more recently, the French have built a storage ring at Orsay (but are apparently limited to wavelengths only above 3 Å).

A large number of experiments are currently underway in Europe and in the US on biophysics and the physical sciences. There are exciting possibilities that crop up when one is given the opportunity to get hold of such high, well-collimated x-ray intensity. But, while the rush is on, it should be noted that Glazer and his co-workers warn the neophytes that it is no simple matter to move an experiment from an x-ray lab to a synchrotron. New possibilities and conditions arise

which must be taken into consideration. This is a growing field which will move very rapidly in the next few years. It would be nice if the US could play an active role. (H. Herman)

MATHEMATICAL SCIENCES

FIFTH INTERNATIONAL CONFERENCE ON NUMERICAL METHODS IN FLUID DYNAMICS

The Twente University of Technology has a new campus of such architectural intrigue and natural beauty that it is difficult to refrain from an effort to portray these virtues here. We shall steel ourselves, however, and confine our remarks to the equally interesting, but less aesthetic aspects of the Fifth International Conference on Numerical Methods in Fluid Dynamics (ICFD) held there from 28 June to 2 July. The University, with a capacity for about 3000 students, is located near the city of Enschede in northeast Holland adjacent to the German border. (This, if we may be permitted a single diversion, is mainly why there are only about 1000 youths using what must undoubtedly be one of the most attractive student environments in Europe--they think Enschede is too remote from "where the action is" in the Netherlands.)

The ICFD is now a biannual conference, in a series that began in Novosibirsk in 1969 and is destined to return to Russia for the next meeting in 1978. With considerable support from ONR, the Conference was sponsored by an international organizing committee chaired this year by Prof. A. I. van de Vooren of the University of Groningen. The proceedings are to be published by Springer Verlag as a volume in the series titled *Lecture Notes in Physics*, and are highly recommended as source material for specialists as well as new entries into the field. (Many ESN readers will be dismayed, as we were, to learn that the publication date is to be "soon.")

The scope of the subject was nicely matched to the size of the Conference with many enthusiastic interactions between the delegates who numbered about 170. They came from most Western European countries, Great Britain, Russia, the Middle East, North America, and South America (Japan was apparently not represented) and there were representatives from both industrial and academic institutions, and from the mathematics and engineering sides of the subject. No formal topical divisions were provided, so any such effort here is necessarily approximate. But, roughly speaking, well over half of the some 55 papers were devoted to the solution, in some form or another, of the Navier-Stokes equations governing viscous flow past bodies. Within this group there were several sets of papers concerning steady and unsteady compressible and incompressible flows. The solutions, in most cases, were carried out by a finite difference technique, often very cleverly implemented in terms of discretization schemes, numerical procedures, coordinate transformations, and other computational tactics. Several presentations dealt with less-general cases of inviscid flows, with about a dozen papers on transonic problems predictably dominating this area. A few papers (not too many) were devoted almost entirely to numerical techniques with no more than a casual reference to fluid mechanics; and a miscellaneous category would have to be mentioned in order to include topics such as bio-engineering flows (internal flows with pulsating walls), detonations and blast-type flows, cosmic phenomena, and other interesting but sundry matters (fluid dynamicists like to quote the Greek motto: παντα ρει - "everything flows").

Always of interest are methods of reducing computer storage and increasing speed, and many papers showed promise in this area. Prof. S. G. Rubin (Polytechnic Institute of New York) discussed his investigations of methods using polynomial spine interpolation techniques to approximate spatial gradients within computational meshes. These methods represent very interesting alternatives to finite difference methods, and offer several advantages: (a) higher order accuracy and lower truncation errors (with cubic splines) than with five-point differences, (b) accuracy with spline approximations is less sensitive to mesh nonuniformity, (c) boundary conditions involving derivatives are more easily handled, and (d) calculation times and computer storage are much less. As an example, Rubin cited a calculation of a standard flat-plate boundary layer problem. Using a spline-4, he found that accuracy was parallel to that obtained with finite difference, but there were 1/4 the number of grid points needed in each dimension (1/16 less for the two-dimensional problem),

a 50-75% reduction in time, and a reduction in storage. Rubin warned that there can be an explosion in the spline techniques since the number of splines and their combinations is very high. He has shown that several different-appearing techniques are actually the same.

Further in pursuit of computational efficiency, Dr. R. W. MacCormack (NASA Ames) discussed a new numerical method for rapidly solving hyperbolic systems of equations. The numerical method is conservative, explicit, and stable, with time-steps orders-of-magnitude larger than those allowed by the Courant, Freidrich and Lewy stability criteria for conventional explicit schemes. In combination with a parabolic technique for treatment of the viscous terms in the Navier-Stokes equations, the hyperbolic operator leads to a drastic reduction in computing time--by factors of 5 to 100--for high Reynolds number flows. MacCormack illustrated this combined method by means of calculations of shockwave interactions with laminar and turbulent flat-plate flows at Reynolds numbers of 2.96×10^5 and 2.96×10^6, respectively.

The paper of Dr. G. Marshall (Lab. de Análisis Numérico, Buenos Aires) was particularly interesting because in his analysis of two-dimensional incompressible viscous flows with heat and mass transfer he conducted several comparisons of various solution schemes. A popular pastime these days is to compare the finite element method (FEM) with the finite difference method (FDM). Marshall's opinion is that the two methods are basically equivalent and subject to similar limitations on stability and accuracy. The comparisons always depend upon the method of handling the boundary conditions, and it can, in fact, be shown that the FEM and FDM are exactly equivalent under special conditions on the computational mesh shape, the continuity of interpolating polynomials, and other selectable criteria. This point of view appeared to be acceptable to the audience; and A. Ecer (Middle East Technical University, Ankara), for example, remarked in his presentation titled "A Model Analysis of Unsteady Incompressible Flow Problems Using Finite Element Method," that the FEM is essentially a discretization method (as is the FDM) that sometimes gives advantages with respect to boundary conditions, and sometimes not.

The transition from tenet to myth of the supremacy of FEM for handling complex boundary conditions was further accelerated by Prof. J. F. Thompson (Mississippi State U.) who reported on some rather fantastic advances in the use of the FDM for the solution of such problems. (The report was coauthored by four others from a variety of industrial labs.) In this work the flow boundaries, regardless of shape, number, movement, or free surfaces in the flow, are fitted with a curvilinear coordinate system. The coordinate transformation relationships between this system and a fixed rectangular field with a square grid are generated and retained in the process so that the square grid may be used for solution of the governing differential equations. The method is both powerful and elegant, having such features as coordinate line concentration in regions of large gradients, and automatic mesh contraction in higher Reynolds number flows. Thus far, applications have included two-dimensional cases only, with current efforts being directed towards the ambitious task of treating (2-d) transonic unsteady turbulent flow about an arbitrary airfoil. The complete description of the method and a user's manual are soon to be published as a NASA Contractor Report by Thompson, F. C. Thames and C. W. Mastin, titled, "Boundary-Fitted Curvilinear Coordinate Systems for Solution of Partial Differential Equations on Fields Containing Any Number of Arbitrarily-Shaped Two-Dimensional Bodies." The report is recommended, if only to see the example of flow past a rock.

The general discussion held on Thursday afternoon was especially enjoyable and informative. Under the masterful moderation of Prof. K. Stewartson (Univ. College London), who even went to the trouble of "planting" contributors in the audience, many delegates got in their "two-bits worth" on the general topic of "where do we go from here?" The questions considered such items as meeting topical content (preponderance of problems in aerodynamics--how about meteorology, geophysics, astronomy, etc.?); the need for more user-oriented codes (the limited fraternity of technologists who cannot mishandle existing programs); self-correcting codes (sense impending inaccuracies and take appropriate steps); and standardization (a big problem--the list of methods is growing like topsy, and there are no standards, or standard problems, for comparison). The idea was expressed that workers in computational fluid dynamics are gravitating together in "Reynolds-number camps." On the one hand, there are those who despair of

the inability to handle computational meshes that are sufficiently fine to cope with the minute scale of the flow details at even moderate Reynolds numbers (less than 1000). On the other hand, there is the high Reynolds number camp, with leaders like MacCormack who refer to "prophets of doom" who need to resolve all flow scales in all directions when experiments, and results that work, show that valid approximations are available that exploit the dominant importance of length scales normal to the flow boundary. Purists and pragmatists--the Hatfields and McCoys of analysis.

Regarding future emphasis, we would have to put turbulence modeling in its usual position at the top of the list. This would be followed, somewhat distantly, by three-dimensional flows and solution methodology. The meeting was a success by every measure of "goodness" applied to such activities. We were impressed by the diversity of methods and approaches, and the degree of sophistication that has developed. The problems spanned a very wide range of geometries, Reynolds numbers, and Mach numbers, and accuracy and stability were satisfactory for many engineering applications. The Fifth ICFD established several new milestones in a field that is expanding with sometimes-frightening speed. If viewed in a timescale bounded by Prandtl's conception of the boundary layer at the turn of the century, the recent years represent something of a quantum jump in the complexity of soluble problems. Many must hope that insights such as that of the boundary layer are not preempted in the future by burgeoning computational capacities. [R. H. Nunn and R. B. Grafton (ONR New York)]

ONRL REPORTS

See the back of this issue for a list of current abstracts, and how to obtain the reports.

MISCELLANEOUS

INTERNATIONAL SYMPOSIUM ON INFORMATION THEORY

Approximately 200 papers were presented at the 1976 International Symposium on Information Theory, which took place 21-24 June at a resort hotel with excellent conference facilities on the edge of the town of Ronneby in southeastern Sweden. The 307 participants came from 26 countries--117 of them from the US, 56 from Sweden, 25 from France, and 20 from the Netherlands. Of the 254 papers that had been accepted by the sponsoring organization, the IEEE Information Theory Group (ITG), nine had come from the USSR. Despite growing cooperation between the USSR and the IEEE ITG, however, the Soviet Union sent no one to the Symposium.

Pursuant to an agreement between the ITG and the USSR Working Group on Information Theory signed late in 1974, there had been an ITG-USSR "workshop" at Pushchino (near Moscow) in December 1975, and the 29 papers presented there (14 from the USSR) are soon to be available from the IEEE Service Center in New Jersey under IEEE Catalog No. 75CH1167-6IT. The second such Information Theory Workshop is planned for the week of 3 October 1977, in New York, and so no slight was evidently intended to the present Symposium; perhaps all Soviet travel to foreign meetings was limited in order to conserve foreign exchange.

Except for special lectures to be described below, the papers were presented in five or six parallel sessions, to which it would be impossible to do justice here. The book of abstracts of the papers accepted for the conference is available from the IEEE Service Center under Catalog No. 76CH1095-9IT. The topics of the Symposium's sessions included detection and estimation (six sessions), pattern recognition (two), topics in information theory (two), coding theory (four), Shannon theory, spectral analysis, fiber-optic and quantum communications, multi-user communications, intersymbol and interchannel interference, queuing and networks, speech processing, source encoding (two), multiple communication, random processes, applications of point-process theory and image processing, and time series.

Five last-minute papers were presented in a special session on recent research topics whose abstracts are not included in the program book and whose titles are therefore included here: "An Equalizer Structure with Reduced Sampling Time Reference Sensitivity," by Lars-Erik Eriksson (Sweden); "Recent Queueing Theoretic Advances in Scheduling Theory," by Bart Stuck (US); "Exact and Approximate Filtering in Signal Detection: An Example," by Mark H.A. Davis (UK); "A Recursive Least Mean Square Adaptive Filter," by Paul L. Feintuch (US); and "Pitch Synchronous Encoding Methods for Speech Signals," by R. Steele and C. Xydeas (UK).

As has become usual, the Soviet papers were scheduled last in each session, but there is a growing feeling that the issuing of special invitations only to Soviet scientists and the special treatment of their papers may be undesirable both because it may lead to counterproductive concessions and because the Soviet scientists themselves want help from the outside in moving their government toward the generally accepted *modus operandi*. There were, of course, more American authors than Soviet who failed to find their way to the Symposium, just over half the accepted papers being from the US. It may also be noted that, although the ITG is the most international of the IEEE's 30 Groups and Societies, English was the sole language of the meeting. (It was also the sole language of the December 1975 workshop in Moscow, but the Soviet participants there suggested the workshop in New York be conducted in Russian!)

In the keynote address, F.Louis H.M. Stumpers (Philips Research Lab, Eindhoven, The Netherlands) discussed the history of the information-theory symposia, which began in London in 1950 and 1952, continued at Berkeley in 1953 and MIT in 1954, returned to London in 1955 and 1960, took place in Brussels in 1962, etc. These symposia, now with the sponsorship of the IEEE ITG and the co-sponsorship of the Union Radioscientifique Internationale (URSI), alternate at about 18-month intervals between the US and other locations, and the USSR has established a parallel series of international symposia on information theory, of which the fourth took place 15-19 June 1976 near Leningrad.

In a special invited lecture entitled "Stochastic Processes: The Rise and Development of a Theory," Prof. Harald Cramér, retired chancellor of the Swedish Universities, presented portions of a paper "Half a Century of Probability Theory: Some Personal Reflections," which is to appear this fall in the *Annals of Probability*. He traced the study of random processes from 1900 to the middle of the century, when Claude Shannon's theory of information was published and stirred activity on the part of many people. The talk was especially interesting for its historical perspective and its statistical viewpoint, which differs considerably from the pragmatic, engineering approach to the investigation of random processes.

The Shannon Lecture--the third in a series in which the first lecture was presented by Claude Shannon himself at the 1973 information-theory symposium in Ashkelon, Israel, and the second by David Slepian at the Notre Dame symposium in 1974--was delivered by Robert M. Fano (MIT). His topic was "Computer-Mediated Communication," and he mentioned the use of a computer to retrieve information about the preferences of a customer reserving a rental car (and even the date of expiration of his driver's license in case it's about to need renewing) in order to personalize the communication and give him confidence in the transaction. He discussed the ARPA computer network with its many terminals as an example of a means for passing messages to people wherever they may be--simply putting into their files the information that a message of a certain length on a specified topic can be retrieved from the sender's file (and thus not filling the recipient's file with "junk mail"). Fano offered the opinion that the video telephone will not find widespread use because it would force people always to look presentable--or to admit they are not by shutting-off the camera.

Another special invited lecture, on "A Return to Input-Output Methods in Statistical System Theory," was delivered by Prof. Thomas Kailath (Stanford) who, taking up where Cramér had left off, introduced the notion of a nonstationary random process whose distance from stationary is d, in the sense that d times as much computing is required in order to make use of data.

The banquet speaker was President Jerome B. Wiesner of MIT, who reminisced about the interdisciplinary work at MIT during the late 40's and early 50's on neural nets, noise theory, human language, computer translation, and the stability of feedback control systems including living systems from the cellular to the societal level. Since those days information theory has become a much narrower discipline, pursued principally by electrical engineers who are often too specialized to communicate even with one another. Putting on his hat as former Science Advisor to President Kennedy, Wiesner offered a contrast between the scientist and the politician. The former, he said, is expected to admit his mistakes but the latter is expected to make none and so feels compelled to adhere to policies that he has come to recognize as wrong. As a result, he pointed out, we have the continuing pollution of the environment and the profligate use of energy.

Despite the unanticipated heavy program, which resulted from the submission of an abundance of good papers, the Symposium must be judged very successful in effecting a pleasant interchange of ideas by workers from many countries. Credit for its success goes principally to Prof. Lars H. Zetterberg of the Royal University of Technology, Stockholm, and to Dr. Robert Lucky of the Bell Telephone Laboratories, Holmdel, NJ. The next International Symposium on Information Theory will take place at Cornell University on 10-14 October 1977. (Nelson M. Blachman, GTE Sylvania Electronics Defense Laboratories, Mountain View, California)

NEW UK SCIENCE ADVISORY MACHINERY

All countries periodically re-examine and refurbish their machinery for injecting advice on science at high government levels, where presumably it will aid in determining national policies as well as help to establish R and D priorities within the scientific community itself. In light of the recent US decision to re-establish an Office resembling the old White House Office of Science and Technology, headed by a Science Advisor to the President, recent overhauls of the UK scientific administrative machinery are perhaps of special interest.

In contrast to the American action, the post of the UK Government's Chief Scientific Advisor, last held by Sir Alan Cottrell and vacant since his retirement from that position about two years ago, has finally been abandoned altogether. Instead, HM Government has recognized the increased responsibility and effectiveness of Departmental Chief Scientists, and has consequently adopted a committee-oriented approach to coordinate Departmental efforts and provide concerted science advice to the highest governmental levels, viz., the Cabinet and the Prime Minister.

A number of new elements are involved in this overhaul of advisory machinery. First, a new Advisory Council for Applied Research and Development (ACARD) will be established, chaired by a member of the Cabinet, Lord Shepherd, the Lord Privy Seal. (The Deputy Chairman will be Sir James Menter, Director of Research and Development at Tube-Investments Ltd. and a Director-designate of Queen Mary College, London.) The terms of reference of ACARD specify that it is to be concerned primarily with applied research and development, the future development and application of technology, and the role of the UK in international collaboration in the field of applied research and development (underlines mine). These applied science functions are to be meshed with corresponding efforts in (basic) scientific research, which come under the responsibility of an existing council, the Advisory Board for the Research Councils (ABRC). Thus, the combined review efforts of ACARD and ABRC will, in effect, form a Council for Science and Technology.

Secondly, in order to inject this advice at appropriate governmental levels and to ensure that the science/technology viewpoint is well integrated with economic/political considerations to give a unified basis for governmental action, there has been a reorganization of the Cabinet Office--a body which, among other functions, coordinates R and D in the separate Departments and passes advice to the Cabinet. The Science and Technology Secretariat in that Office has been amalgamated with the Economic and Industrial Secretariat to form a multi-disciplinary group, and other steps have also been taken which will lead to a mixing of the scientific and political-economic staffs. Finally,

a committee of Chief Scientists and Permanent Secretaries from the various Departments will be formed under the chairmanship of the Secretary of the Cabinet, an official of the Cabinet Office.

Thus, collective action and the interplay of a hierarchy of committees seems to be the administrative wave of the future for British governmentally-supported research and development. Actually, this is probably the way it has been for a long time in Britain and the world over. What is interesting, however, is that the British, unlike ourselves, no longer find it either appropriate or necessary to provide symbolic public recognition of science by designating one man as Chief Science Advisor to the Government. This may stem from the fact that British science is (and has been for some time) already recognized at Cabinet level via a Secretary of State who heads the Department of Education and Science.
(J.H. Schulman)

OCEAN SCIENCE

THE LIÈGE COLLOQUIUM ON OCEAN HYDRODYNAMICS

The Eighth International Liège Colloqium on Ocean Hydrodynamics was convened by Prof. Jacques C.J. Nihoul at the Institute of Mathematics of the University of Liège, Belgium on 31 May 1976. The nominal topic of the five-day conference was "Bottom Turbulence," and 22 papers were presented by participants representing institutions in Belgium, England, Germany, Italy, Scotland, Spain, Sweden, US and the USSR. The relatively uncrowded daily schedule allowed speakers adequate time to develop their subjects in some detail and provided ample opportunity for stimulating discussions following each presentation.

Several of the papers viewed bottom turbulence in relation to sediment transport. Topics included both the interaction between sediment load and the turbulent structure and measurements of boundary layer parameters associated with sediment movement. Nihoul considered the case in which sediment in suspension results in an apparent drag reduction due to the formation of an elastic sublayer close to the bottom. He showed that this situation can be mathematically modeled without recourse to varying Von Karman's constant. J. Duncan Smith and S.R. McLean (Univ. of Washington) presented both theoretical arguments and experimental evidence to demonstrate the importance of self-stratification of boundary layer flows due to sediment in suspension. They showed that this effect can considerably influence the slope of the mean velocity profile. Very practical problems of sediment transport in shallow waters were discussed in papers by C. Book (Naval Underwater Systems Center (NUSC), Newport, RI) and J. Peters (Lab de Rech Hydrauliques, Belgium). The former compared several methods of bottom stress measurement, used at a dredge dump site off the coast of Connecticut. Results obtained by log profile, quadratic law and dissipation techniques proved to be consistent. Peters described an extensive program of sediment transport and flow measurements in the Zaire River as they related to maintenance of navigable channels by selective dredging of specific bottom features. J. Rodhe (Univ. of Gothenburg, Sweden) proved conclusively that human ingenuity has not been completely displaced by integrated circuits and microprocessors. He presented a series of measurements derived from simple, inexpensive, vane current meters. Rodhe's experimental technique proved to be well adapted for rapid survey of two-dimensional current-flow structure and calculation of turbulence parameters relevant to bottom-transport processes. The role of bottom turbulence in the development of deep ocean-bed forms such as furrows and long, mud waves was discussed by R. Flood [Woods Hole Oceanographic Institute (WHOI), MA]. He showed both acoustic and photographic evidence that these as yet unexplained features may be widely distributed over the sea floor. The problem of the influence of boundary-layer turbulence on the diffusion of chemical species in the sediment was described in a paper by J. Vanderborght and R. Wollast (Univ. Libre of Brussels, Belgium). Their results indicated that mass-transfer coefficients in the interstitial water may be a function of the turbulent intensity in the boundary layer.

Other talks considered a broad range of topics that were not directly related to problems of sediment

transport. The character of the deep-sea, bottom-mixed layer was the subject of several speakers. Based on a combination of Current-Temperature-Depth (CTD) data and current observations from the Mid-Ocean Dynamic Experiment (MODE), L. Armi and R. Millard (WHOI) showed that the mixed layer penetrates to a thickness greater than the Ekman height. On the abyssal plain the penetration height depends on current speed, while in the presence of more highly structured bottom topography, advection effects of mesoscale eddies are observed. J. Sarmiento (Lamont-Doherty Lab, Palisades, NJ) presented an extensive set of world-wide geosecs measurements of radon in the benthic boundary layer that were obtained in combination with simultaneous CTD profiles. It was shown that in general the radon concentration is rather constant in the homogenous, mixed bottom layer with the sharp density gradient at the top of this layer serving as a barrier to further vertical diffusion of radon. In cases where no well-defined mixed layer was found, radon concentration falls off exponentially with height, and eddy diffusion coefficients can be estimated. A.J. Williams (WHOI) and B. Williams (NATO, SCALANT, Italy) both described prototype acoustic current meter systems for making direct measurements of turbulence in the benthic boundary layer of the deep ocean. B. Williams emphasized measurement of the turbulence dissipation parameter by spectral analysis of one-dimensional velocity fluctuations. The system under development by A. Williams and J. Tochko is designed to measure velocity fluctuations to determine three-dimensional turbulent structures and Reynolds stresses.

The remainder of the presentations dealt with conditions existing in shallower waters. G. Weatherly (Florida State University) discussed Ekman veering in bottom boundary layers. His analysis indicates that in cases where isotherms intersect a sloping bottom there cannot be a steady-state boundary layer; it will either be absent, or there will be advective effects. Papers by J. Salat and J. Font (Inst. Inv. Pesqueras, Spain) and P. Kundu (Oregon State Univ.) considered problems associated with interpretation of bottom, return-flow currents accompanying upwelling off the coasts of Oregon and Africa. A. Edwards (Scottish Mar. Biol. Assn, Dunstaffnage) analyzed a series of measurements taken during the intermittent replacement of bottom water in a fjord by flow over a seaward sill. C. Gordon and J. Witting (NRL, Washington, DC) presented some direct measurements of two-dimensional, bottom turbulence in a tidal channel. They showed that the turbulent motions can be viewed as a dual population; large-scale coherent structures responsible for vertical momentum transport and small-scale, isotropic, background turbulence. W. Criminale (Univ. of Washington) introduced a unique perspective in which he considered a bottom boundary at the top. He analyzed the particular case of flow under freezing ice with residue brine sinking through the boundary layer to produce mass-driven fluctuations. Measurements of the vertical distribution of turbulence in a shallow sea, submitted by I. Lozovatsky and R. Ozmidov (Shirshov Inst., USSR) indicated a possible stratification of turbulent kinetic energy in the bottom mixed layer and through thermoclines. The case of strong tidal currents in shallow seas, in which bottom-generated turbulence produces a mixed layer that extends all the way to the surface, was examined in detail by R. Pingree and D. Griffiths (Marine Biological Assoc., Plymouth, UK). They showed that this phenomenon produces recognizable biological results as well as physical results. M. Bowman (State Univ, NY) discussed the role of bottom turbulence as a possible mechanism for generation of frontal systems in Long Island Sound. H. Ramming (Univ. of Hamburg, Germany) and A. Davies (Institute of Oceanographic Sciences, Birkenhead, UK) both emphasized the importance of proper consideration of bottom friction and the vertical distribution of eddy viscosity in numerical models of large-scale flows in shallow seas.

Needless to say, this report can provide only a limited overview of the subject material presented at the Colloqium. Complete texts of the papers will be subsequently published in the *Memoires de la Société Royale des Sciences de Liège*. By unanimous decision the social highlight of the meeting was the Colloqium Banquet at Château de Colonster on the Sart Tilman Campus of the University of Liège. The dinner was arranged and hosted by Prof. and Mme Nihoul with an elegance characteristic of the best in European hospitality. (C.M. Gordon, NRL)

PHYSICAL SCIENCES

DESTRUCTION OF KIDNEY STONES BY LASER-INDUCED STRESS WAVES

During his recent tenure of a US Secretary of the Army Research and Study Fellowship at the Royal Institution of Great Britain (London), Dr. Harry Fair of Picatinny Arsenal combined laser technology and the principles of shock-wave interactions with solids to produce a potential non-surgical treatment for urinary calculi (kidney and bladder stones). Fair demonstrated that large-amplitude stress waves, generated in a special device by high-intensity laser pulses, could shatter kidney stones into particles of sufficiently small size to make it possible for them to pass without difficulty in the normal urinary stream *in vivo*. An abstract of the work appears in a Report by Sir George Porter, Director of the Davy Faraday Research Laboratory, in the annual *Record of the Royal Institution* for 1975, and the paper has been submitted for publication.

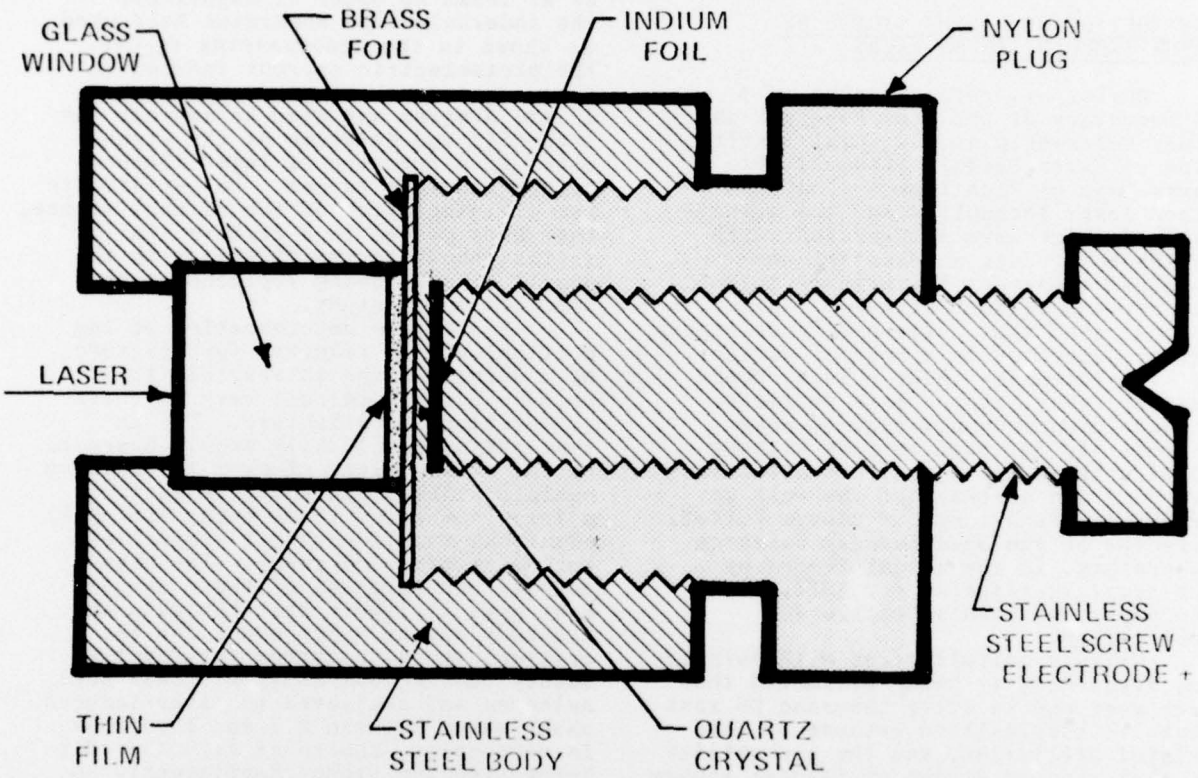
Urinary calculi occur with surprising frequency, it being estimated that each year one in every thousand US residents is hospitalized because of this painful affliction, and the probability of formation of kidney or bladder stones during a person's lifetime is well over 10%. Although smooth-surfaced stones as large as 5 mm in diameter may be passed spontaneously, surgical treatment is generally necessary to deal with calculi of this size.

Unlike many other laser applications to cutting, drilling, welding, and surgery, the laser light is not directly applied to the calculi. The shock waves are produced in a separate device and directed against the stones. In his investigations Fair employed the "confined blow-off" technique of N. Anderholm [*Appl. Phys. Lett.* 16, (1970)] to generate shock waves having approximately 10 Kbar peak pressure, with rise-times of approximately 20 nsec and widths of 25 nsec (FWHM), by irradiation of a 1-μm thickness aluminum film confined between glass and metal substrates, using a Q-switched ruby laser with an output of 1.8 J. Stress waves are generated in solid targets as a consequence of the vaporization of surface material to form a "blow-off" plasma. Anderholm found that by confining this plasma between the (thin film) target and a transparent solid, the stress wave could be enhanced by at least an order of magnitude. The Anderholm-type apparatus Fair used as shown in the accompanying figure. The piezoelectric current induced in the x-cut quartz single crystal shown in the diagram was used to measure the intensity and duration of the stress waves as a function of laser fluence on the aluminum target. To investigate the disintegration of the urinary stones, they were placed in a fixture similar to that shown in the figure, with the quartz crystal being replaced by the specimen under study.

An accurate determination of the critical stress required for fracture of a urinary stone is very difficult because urinary calculi vary in their composition and structure. The investigation was luckily aided, however, by the availability of over 100 calcium oxalate stones from a single patient, a large number of these being virtually identical in all physical properties, including size and shape. The high density and hardness of these specimens make it likely that the data obtained yield an upper bound for the critical stress required for fracture. Twenty of the most similar stones were selected and subjected to laser-induced shock waves between 0.2 and 10.0 kbar. In most cases, shocks of 5-10 kbar disintegrated the stones sufficiently so that the resulting particles might be expected to be passed by natural means.

Before *in situ* destruction of stones can be attempted by the laser-induced shock-wave technique, a number of questions remain to be investigated. First, the shock-wave device would have to be able to function at the end of a flexible light-guide or fiber-optic bundle that could be inserted into the renal system. Fair found that shocks produced by focusing the laser output through six feet of commercially available fiber optics onto the test device were essentially identical to those produced by direct irradiation. A further practical problem is to ensure that the shock wave is adequately coupled to the urinary calculus *in vivo*, for the stone must be in direct physical contact with the shock-producing device in order to achieve good fragmentation. Fair is experimenting with a number of mechanical devices and suction to provide good mechanical contact.

SHOCK GENERATION FIXTURE



The energy of the shock waves should all be utilized in creating fragments with little or no kinetic energy, in order to avoid damage to the surrounding tissue. Measurements are currently in progress to determine the fragment velocity as a function of incident shock-wave parameters. Fair points out, in this connection, that very little is known about the effects of stress waves on tissue. Although little coupling is expected between the shock-generating system and tissue in any actual operating device, experiments are nevertheless in progress to see what effects would be produced when shock waves are absorbed by tissue.

Finally, Fair notes that models of laser-induced shock-generation mechanisms predict a very major increase in shattering ability as the laser pulse-width is reduced from micro- or nano-seconds to picoseconds, and he is exploring this possibility.
(J. H. Schulman)

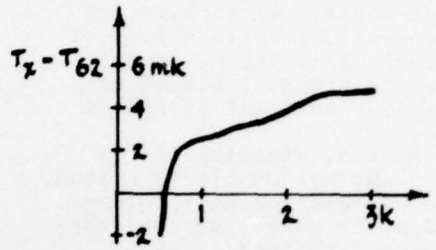
THERMOMETRY AND TEMPERATURE SCALES

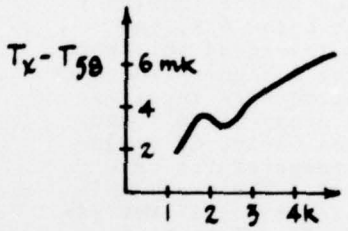
On 4 June the Low Temperature Group of the Institute of Physics held a short one-day meeting in London on Thermometry. The timing of the meeting was excellent--one week before the Paris meeting of Working Group 4 of the Consultive Committee on Thermometry, CCT, the Group concerned with temperatures below 100 K. Consequently, two Americans interested in thermometry just happened to be passing through England, and the questions on the agenda of the Paris meeting could be discussed with a full knowledge of the results of the experiments initiated by the CCT. About 30 attended the meeting, a fifth of which were associated with the National Physical Laboratory (NPL) in Teddington, the British equivalent of the US National Bureau of Standards (NBS). I have noticed in North America that the number of people interested in precise and accurate thermometry is not large, but the lack of numbers is more than made up by their intense

interest in the subject. I now conclude that the European counterparts are from the same mold because the discussion was lively and detailed.

Professor C.A. Swenson (Physics Dept., Iowa State University, Ames) spoke on the thermodynamic temperature scale between 1-30 K. (As most ESN readers will remember there is a temperature scale, $He^4(58)$, internationally recognized in 1958, which is a reconciliation of the He^4 vapor pressure (v.p.) scales used at the Kamerlingh Onnes Laboratory and the Naval Research Laboratory, both of which were developed in 1955. Similarly, the hydrogen v.p. scale established in 1968 is designated as $H_2(68)$.) Swenson reviewed various recent absolute determinations of the boiling points of He^4 and H_2 to illustrate the difficulties with these v.p. scales. The figures suggest that $He^4(58)$ scale is about 7 mK too low and that the $H_2(68)$ scale is as much as 9 mK too high at the normal boiling point. In view of these difficulties, Working Group 4 is considering anew what type of thermometry is to be used as the primary standard and what scale is the closest to the true thermodynamic temperature on that thermometer. Swenson presented a critique of magnetic, acoustic, resistance, and gas pressure thermometry and was in favor of retaining the gas thermometer because of the experimental ease--or at least the experimental problems are well known--and because of the advent of the new digital pressure gauges working on the capacitance technique. The equation of state $PV=n\,RT\,(1+B(T)/V)$ where $B(T)=a+b/T$ is theoretically justifiable and if, used to define T_g, it consistently provides a scale accurate within a fraction of a mK to the thermodynamics temperature. Still, it is necessary to find a and b by calibration at, say, 4.222 K and 20.271 K, the normal boiling points of He^4 and H_2.

Dr. R.L. Rusby reviewed the work at NPL on the He^3 and He^4 v.p. scales and on the magnetic susceptibility, χ scale from cerium magnesium nitrate (CMN). He described the thermodynamic calculation of T emphasizing the necessity of self-consistent correction terms, i.e., the temperature integrals of the entropy and volume must be made on a temperature scale consistent with the resulting temperature scale. These correction terms are much more significant in He^3 at 1 K than for He^4 near the λ-point. Rusby described a carefully-designed cryostat used to compare the He^4 v.p. scales with the CMN T_χ. Rusby's results were roughly:





Dr. S.D. Ward (NPL) discussed the definition of the 1968 International Practical Temperature Scale (IPTS) based on platinum resistance (PR) over the range of 13.81 to 273.15 K. The scale utilizes various specified fixed points such as the normal boiling points and triple points of H_2, N_2, O_2, and H_2O within this range. The PR scale is then defined in terms of specified polynomial forms over four temperature regions between 13.81 and 273.15 K with the function so described passing through the fixed end points of these regions and having a continuous first derivative everywhere over this temperature range. If this sounds complicated--it is! A 1-mK error at one of the fixed points can cause an oscillating error in the IPTS which can be over 1.5 mK in magnitude at some remote point. Ward is now wondering if a single fifth-order polynomial over the complete T range wouldn't be better...

Ward is responsible for a six-year old NPL project to intercompare platinum resistors and their scales from standards laboratories of all participating nations. Ward's report was fascinating--he could tell the source of the platinum used, whether it be Leeds and Northrup, Rosemont, or Tinsley. The intrinsic differences in the platinum caused discrepancies of not more than 4 mK. He was able to measure T

with platinum resistance within 0.3 mK at 4.22 K with his apparatus. The maximum discrepancy for the 45 resistors intercompared up to this time was 11 mK near 13 K, but most were within 4 mK everywhere. Drift during the six years was 0.3 mK at worst. It appears, in terms of the previous calibrations of these resistors, that the H_2 normal boiling point is within ± 0.6 mK between the various national standards laboratories.

Dr. R. Hudson, standing in for Dr. R. Soulen who was unable to attend, reviewed the NBS-Washington intercomparison of Johnson noise, nuclear magnetic resonance (NMR) and γ-ray anisotropy thermometers. The NBS noise thermometer, which uses a Superconducting Quantum Interference Device (SQUID) is currently useful below 4 K, and Soulen is planning to extend this work to higher T by using a higher frequency SQUID. The NMR thermometry involves the free-induction decay of Cu^{63} and Cu^{65} nuclei. In the 50-500 mK range the noise and NMR temperatures have agreed within 0.8 mK. The γ-ray anisotropy work utilized the 1.17 MeV (4+ to 2+) and 1.33 MeV (2+ to 0) E2 transitions originating from Co^{60}. This technique is now well known and the NBS-Washington program is coming to an end.

Hudson then reviewed the NBS-Washington project to provide not-too-expensive easy-to-use fixed-point references based on superconducting transitions. As most readers of ESN know the NBS SRM-767 consists of six superconductors, Pb, In, Sn, Al, Zn, and Cd whose transitions may be detected by a simple $20 susceptibility circuit with a phase sensitive detector. This covers the range from 0.515 K to 7.291 K with points accurate to ±1 mK. Currently NBS is considering a new single crystal Cd with a 10-μK-wide transition to replace the polycrystalline Cd reference whose transition was nearly 2 mK wide. NBS is also considering extensions of the T range by Nb_3Sn (18.00 K), V_3Ga (14.30 K), Nb (9.299 K), $AuIn_2$ (0.203 K), $AuAl_2$ (0.150 K), Ir (0.112 K), Be (0.024 K) and W (0.015 K). Hudson reviewed the metallurgical problems in obtaining reproducible and narrow transitions for these materials. He felt that they may have the Nb problem solved.

More details of these talks and several others not mentioned here are given in ONR London Conference Report C-22-76.

The next meeting of the Low Temperature Group will be at the University of Sussex in August. About every three years the Low Temperature Group awards the Simon Memorial Prize for distinguished work in experimental or theoretical low temperature physics. This year three Americans shared the prize for their discovery of the new superfluid phases of He^3 at Cornell in 1972, Professors D.M. Lee and R.C. Richard, and Dr. D.D. Osheroff (who is now at Bell Laboratories, Murray Hill). The Sussex meeting will become a special Superfluid He^3 Symposium not unlike the Quantum Liquids Symposium held at Sussex some years ago. With many leaders in this area of research expected to attend, it promises to be an interesting occasion. (T.A. Kitchens)

NEWS & NOTES

STAFF CHANGES AT ONRL

We welcome aboard the following scientists who will be with us for periods varying from one to two years:

Dr. William J. Gordon, Mathematics Department, General Motors Research Laboratories (mathematics and computer science).
Dr. Martin Lessen, Yates Memorial Professor of Engineering, University of Rochester (fluid mechanics).
Mr. Aubrey W. Pryce, Deputy Director, SACLANT ASW Center, La Spezia, Italy (acoustics).
Dr. Abraham Sosin, Associate Dean, College of Engineering, University of Utah (materials science).
Dr. W. G. Soper, Naval Surface Weapons Center, Dahlgren, VA (NSWC representative to the UK).

We bade farewell to the following scientists who have returned to the positions indicated:

Dr. David K. Cheng, Professor of Electrical Engineering, Syracuse University, NY.
Dr. Larry G. DeShazer, Director of the Center for Laser Studies, University of Southern California, Los Angeles.
Mr. Frederick J. Gleason, Naval Surface Weapons Center, White Oak, MD.

Dr. Herbert Herman, Professor and Chairman of the Department of Materials Science, State University of New York at Stony Brook
Dr. Thomas A. Kitchens, Jr., Cryogenics Groups, Los Alamos Scientific Laboratory.
Dr. Leslie H. Meredith, Assistant Center Director, Space Sciences and Applications Directorate, Goddard Space Flight Center, Greenbelt, MD.

Members of the scientific staff who are still with us are Dr. James H. Schulman, Dr. J. B. Bateman, Dr. James W. Miller, and Dr. R. H. Nunn.

NAME CHANGE

Notice has been received of a name change for the Reactor Centrum Nederland (RCN) (Netherlands Reactor Center). As of 1 August 1976, the new name shall be Netherlands Energy Research Foundation (ECN) or Stichting Energieonderzoek Centrum Nederland.

PERSONAL

Professor P. J. Black, Professor of Physics, University of Birmingham, has been appointed to the Chair of Science Education at Chelsea College, University of London.
Professor A. C. Chamberlain, member of the staff at AERE Harwell, has been appointed special Professor of Environmental Physics, School of Agriculture, University of Nottingham.
Sir Hugh Ford has been appointed a member of the Agricultural Research Council to replace Professor A.R.J.P. Ubbelhode who has retired.
Dr. V. Heine, FRS, Reader in Theoretical Physics, University of Cambridge, has been elected into the Chair of Physics.
Dr. A. E. Long, Senior Lecturer in Civil Engineering, Queen's University of Belfast, has been promoted to the Chair of Civil Engineering at the University.
Dr. Colin Mortimer, Professor of Chemistry at the University of Keele, has been appointed to a personal Chair in Inorganic Chemistry at the University.
Professor G. G. Roberts, Dean of the School of Physical Sciences at Coleraine, has been appointed to the Chair of Applied Physics and Electronics at the University of Durham.
Mr. A. Wright, Reader in Electrical Engineering, University of Nottingham.

OBITUARIES

Professor Allan Birnbaum, Professor of Statistics at the City University, London, since 1957, died suddenly on 1 July at the age of 53. Birnbaum, an American, is generally regarded as the man who made crystal clear the likelihood principle, and his famous paper of 1962 "On the foundations of statistical inference" was described, aptly, by L. J. Savage as an event "really momentous in the history of statistics. It would be hard to point to even a handful of comparable events."

Professor Henrik Dam, the Danish chemist who was awarded the Nobel Prize for Medicine in 1943 for the discovery of Vitamin K, or phytomedadione, died on 24 April at the age of 81. He was well known in the US as he spent the war years at Woods Hole Marine Biological Laboratories and the University of Rochester, and from 1945 to 1948 he was an associate member of the Rockefeller Institute for Medical Research in New York. From 1956 to 1963 he was Director of the Biochemical Division of the Danish Fat Research Institute.

Professor Douglas E. Elliott, Professor of Mechanical Engineering at the University of Aston, Birmingham, since 1968, died on 15 June at the age of 53. He was one of Britain's leading engineers in the field of heat transfer. He established his international reputation in the field of fluidized bed heat transfer--a system of burning gases and other fuels in a fluidized bed of aerated sand.

Professor Alexander Frumkin, the Russian pioneer of modern theoretical electrochemistry, died on 27 May at the age of 80. His research was primarily in the sphere of surface phenomena and the theory of electrochemical processes. He established the quantitative theory of the influence of the electric field on molecular adsorption and studied the nature of chemical bonds in molecules.

Professor Jacques Monod, the French biochemist who was a joint winner of the Nobel Prize for Medicine in 1965 died 31 May at the age of 6[illegible]. He was Director-General of the Pasteur

Institute. The award of the Nobel Prize to him, in conjunction with Dr. Francois Jacob and André Lwoff, was for the discovery of a previously unknown class of genes whose function was identified to be that of regulating the activity of other genes.

Dr. Nikolai Muskhelishvili, the Russian mathematician and Soviet Academician, died in July at the age of 85. One of the Soviet Union's most distinguished mathematicians, he conducted research into the theory of elasticity; integral equations; and boundary value problems of the theory of functions.

David E. H. Peirson, Secretary of the UK Atomic Energy Authority from 1955 to 1971, died 21 March at the age of 61. He represented Britain for 25 years, both nationally and internationally in atomic affairs. In 1971, he became General Manager of Centec from which he recently retired.

Dr. Robert Spence, CB, FRS, Director of the Atomic Energy Research Establishment, Harwell, from 1964 to 1968, died 10 March at the age of 70. He was Deputy Director of the Establishment from 1960 to 1964. From 1968 he was Master of Keynes College and Professor of Applied Chemistry at the University of Kent at Canterbury. He remained here until his retirement in 1973.

ONRL REPORTS

R-5-76 HOLOGRAPHIC GRATINGS AND ZONE PLATES by W.R. Hunter, Naval Research Laboratory, Washington DC

This report is a tutorial treatment of diffraction gratings and zone plates, with emphasis on modern holographic methods of generating these optical components. The report is based upon recent visits to several research establishments in the UK and on the Continent.

C-15-76 THE WORLD of SUB-SENSORY RECEPTORS: A SYMPOSIUM ON DRUG ACTION AT THE MOLECULAR LEVEL, by J.B. Bateman

This brief report has been built around the facts presented, and impressions received, at a recent symposium on "Drug Action at the Molecular Level." Some background material has been included and the sequence of presentations rearranged so as to illustrate two points that seemed to be implied in the topics chosen by the organizers: (1) the methods currently in use in the investigation of the substrate-receptor relationship, and (2) the relationship between properties and functions of a series of enzymes. Concerning (1) special attention is paid to the attempt to bypass the dominant empirical approach by selecting a well-characterized element of macromolecular structure as "receptor" and designing a "substrate" or "drug" for it on the basis of detailed structural information. In (2) a comparison is made of the characteristics of selected enzymes performing functions related to acid base control, active transport, replication, neuromuscular transmission and drug catabolism.

C-16-76 CONFERENCE ON MAGNETOSPHERIC AND PARTICLE PHYSICS by Maj. M.S. Harris, EOARD

A conference on Magnetospheric and Particle Physics was held during 31 March-2 April 1976 at the University of Sheffield sponsored by the Institute of Physics and the Royal Astronomical Society. The meeting covered the topics of reconnection and convection, structure and stability, particles and their origins, waves, fields, and pulsations in the magnetosphere.

C-17-76 FIFTH INTERNATIONAL SYMPOSIUM ON FRESH WATER FROM THE SEA by Robert H. Nunn

This report summarizes the nature and scope of the conference which attracted some 495 delegates from 34 countries on 16-20 May 1976. The subject coverage of the Symposium is briefly reviewed, and a somewhat more complete description is given of the sessions on Regional Reviews, Economics, and of the use of fluidized beds in evaporative systems. Economy was emphasized in the conference, with major implications regarding the future of multi-stage flash evaporation systems in the presence of rising fuel costs.

C-18-76 WORKSHOP ON THE TREATMENT OF DECOMPRESSION SICKNESS by LCDR K.M. Greene, MC, USN

This report summarizes a workshop held 17-18 February 1976 in London. The thirty physicians attending from seven nations sought a uniform approach to the treatment of decompression sickness in the North Sea environment. Aspects considered include recompression profiles, gas mixtures, ancillary drugs, aftercare, qualifications of assistants, and communication problems. Included in the report is an outline approved by the EUBS for guidance in the choice of treatment tables.

C-19-76 SECOND INTERNATIONAL HEAT PIPE CONFERENCE, BOLOGNA, ITALY by LTCOL Robert F. Lopina, EAORD

This report summarizes the presentations at a three-day international meeting on heat pipe research and developments. The meeting dealt with gravity-assist heat pipes, low temperature heat pipes, variable conductance heat pipes, rotating heat pipes, heat-pipe materials, evaporative heat transfer mechanisms, zero-gravity testing and terrestrial and spacecraft applications of of heat pipes.

C-20-76 MONITORING BEHAVIOR AND SUPERVISORY CONTROL by James W. Miller

This was a five-day NATO sponsored symposium which had as its objective the convening of scientists and engineers involved with the complex man-machine relationships in controlling vehicles and large scale processes. Thirty-eight presentations were given covering the general topics of man-vehicle control, general models and process control. Much attention was given to the changing role of man from controller to system supervisor; to the impact of this change on training, selection, mathematical modeling of complex systems and human performance; and to the measurement of operator workload. Presentations included descriptions of newly developed models, individual display and control systems, and the interaction of man and his computer "slave". Proceedings of the symposium will be published.

C-21-76 1976 INTERNATIONAL ZURICH SEMINAR ON DIGITAL COMMUNICATIONS by LCDR D.C. Rummler

This report reviews selected papers presented at the 1976 International Zurich Seminar on Digital Communications which have potential application to military communication systems. The papers reviewed cover the areas of LSI technology in digital communications, high speed transmission systems, high-frequency channel error detection and correction, integrated picture-display and voice communication systems, architecture and design of a multiple-microprocessor network, error-detection and system reconfiguration in distributed signal processing systems and data network ciphering.

ESN-30-8

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PTARMIGAN: A UK SECURE AREA-COMMUNICATION SYSTEM FOR ARMED FORCES by David K. Cheng

This report summarizes the technical and operational characteristics of the PTARMIGAN system, a UK-developed secure area-communication system for armed forces. It is a computer-based, automatically switched and mobile system that will provide voice, telegraph, data and facsimile modes of operation over a wide geographical area.

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ONRL C-18-75	J.H. SCHULMAN	Conference in Ghent: "Useful Preparative Aspects of Photochemistry"

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